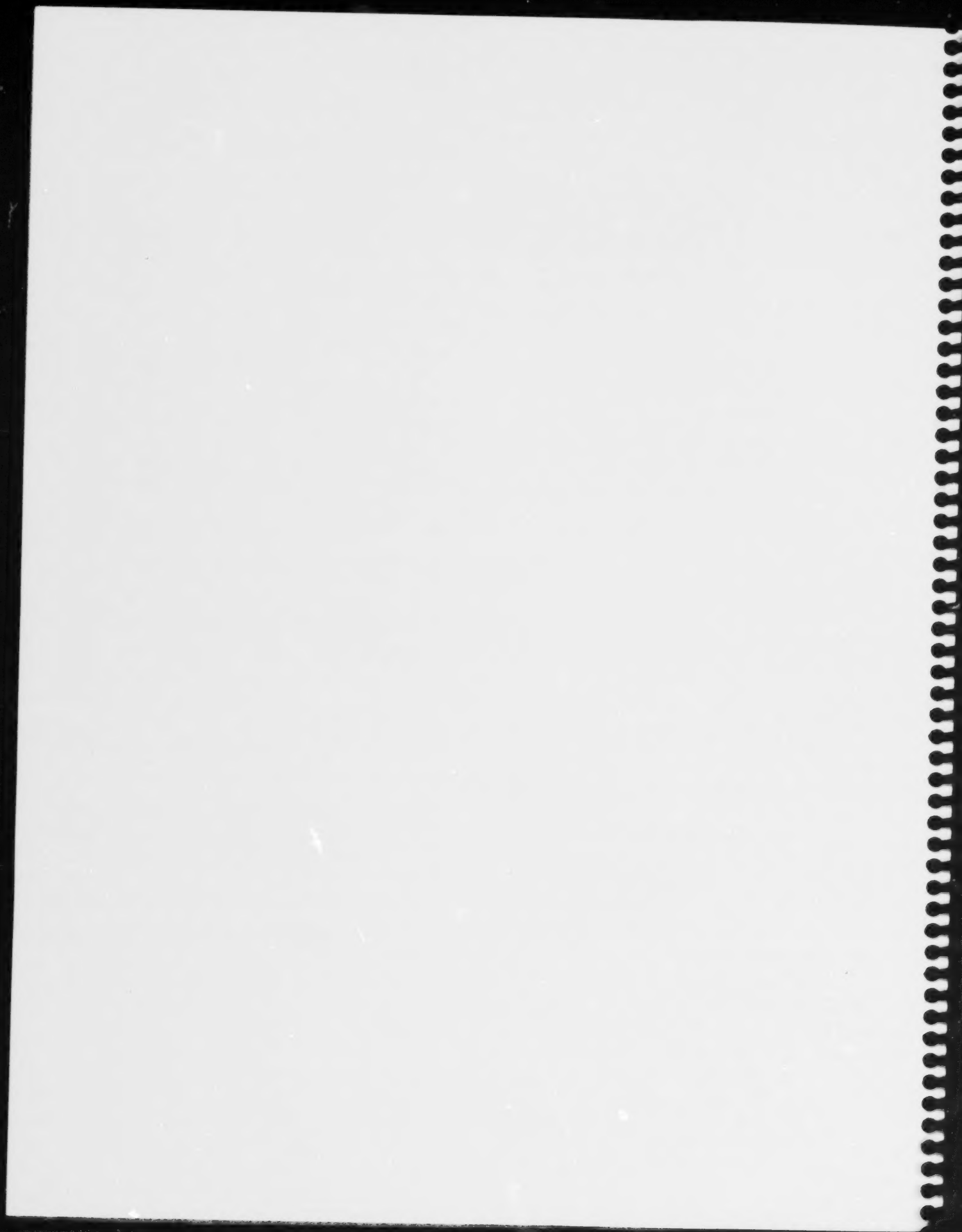
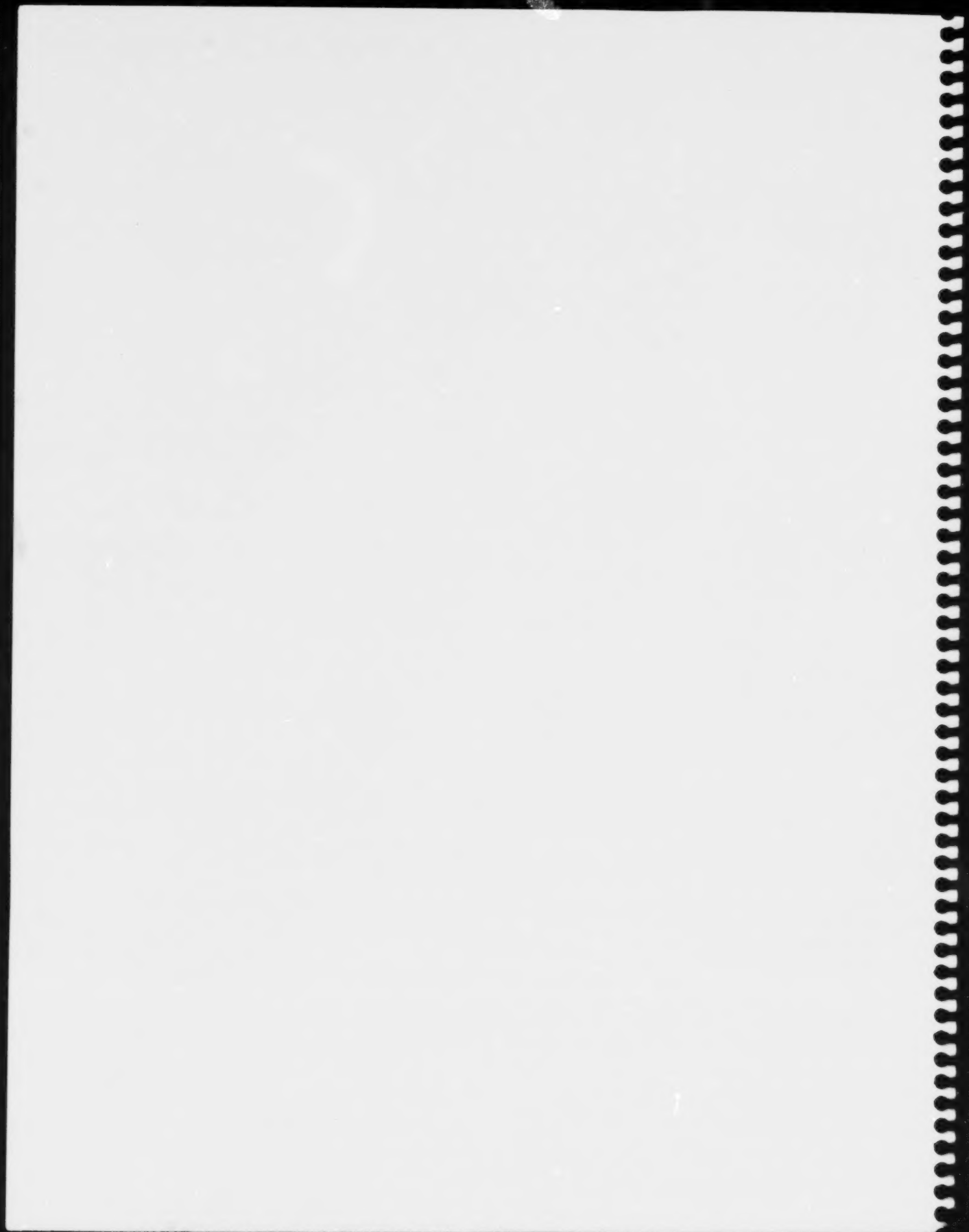


EVALUATION OF BRUCELLOSIS AND TUBERCULOSIS
IN BISON IN NORTHERN CANADA

By: Bison Disease
Task Force

The paper was produced as background material to permit a preliminary analysis of the choices for future management of the diseased bison population in and near Wood Buffalo National Park. It is believed that it will serve as a useful and factual working draft for the Bison Disease Steering Committee.





EXECUTIVE SUMMARY

PROBLEM STATEMENT:

South of the Mackenzie River and generally in and near Wood Buffalo National Park (WBNP), there is a free-roaming population of bison, the cross-bred descendants of the original wood bison (Bison bison athabasca) and plains bison (Bison bison bison) that were introduced to the wood bison range between 1925 and 1928 from Buffalo National Park near Wainwright. The present hybrid herd is infected with bovine tuberculosis and brucellosis, believed to have been brought to the area by the plains bison.

This situation has created two immediate problems:

- (a) that the free-roaming hybrid bison in and around WBNP are infected with the reportable diseases of tuberculosis and brucellosis and, as a result, may spread these diseases to livestock, other wildlife including the endangered wood bison, and man;
- (b) that these hybrid bison may interbreed with the wood bison of the Mackenzie Bison Sanctuary (MBS) or other free-roaming wood bison herds that may be established in the area, causing genetic contamination of the endangered wood bison.

Stated more specifically, these problems include:

- the potential for infection of domestic livestock and captive bison herds with brucellosis and tuberculosis;
- interference with the reintroduction of wood bison and the eventual delisting of this currently endangered subspecies;
- the danger to the health of native and non-native users of bison;
- interference with Canada's credibility as a country with a brucellosis-free national cattle herd;
- the danger of infecting disease-free wood bison in northern Alberta and NWT; and
- the threat to the genetic integrity of free-ranging wood bison.

* In April 1988, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) changed the status of wood bison from endangered to threatened reflecting the current steady recovery and increase of the species of Canada. Wood bison continue to be listed as endangered under the NWT Act and by the Convention on International Trade in Endangered Species (CITES).

BACKGROUND:

In 1922, Wood Buffalo National Park was formed to protect the last known remaining wood bison. Between 1925 and 1928, 6673 plains bison were introduced into the park in an effort to alleviate grazing pressure and range degradation at Buffalo National Park at Wainwright. An area south of the Peace River was added to the park in 1926 to accommodate these additional animals. This transfer was accompanied by considerable debate over the advisability of sending bison known to be infected with tuberculosis into an apparently disease-free area. Unfortunately, though unknown at the time, these animals likely also transported brucellosis to the park and surrounding areas.

The introduced bison and the estimated 1500 wood bison inhabiting the area interbred and increased in number to an estimated 12,000 animals in the late 1940s. Tuberculosis and probably brucellosis spread throughout the herd, and today, it has been estimated that over 50% of the park's herd of 4200 animals are infected with one or both of these diseases.

In recent years, mixed agriculture has moved closer to the park along the Peace River corridor. Game farming, private herds of livestock, and the establishment of grazing leases in the area are increasing the probability that one or both of these diseases will be transmitted from the bison to domestic animals. If this occurs, it would necessitate considerable expenditure of resources in an effort to eliminate the disease(s) and would jeopardize Canada's status as a brucellosis-free, and ultimately tuberculosis-free, nation.

In 1963, 18 disease-free wood bison were transported to the Mackenzie Bison Sanctuary north of the Mackenzie River. These animals were the beginnings of the present day herd of 1600 apparently disease-free wood bison in the sanctuary. It is feared that this rapidly expanding population may soon contact the infected bison to the south, thus causing genetic and disease contamination of the majority of endangered wood bison in existence today.

Seven government agencies with diverse mandates have expressed concern over the present situation and the problems which may arise should these diseases spread to humans, domestic animals or other wildlife. These agencies (Agriculture Canada; Canadian Parks Service; Canadian Wildlife Service; Alberta Agriculture; Government of the NWT, Renewable Resources; Alberta Forestry, Lands and Wildlife; and Health and Welfare Canada) formed a Steering Committee which appointed a multi-agency task force to prepare this evaluation of the problem of brucellosis and tuberculosis in bison in northern Canada.

PREVIOUS MANAGEMENT INITIATIVES:

In 1954, a management plan was proposed for the park's bison. One long-term objective of the plan was to reduce the incidence of disease (primarily tuberculosis) where possible. It was considered at the time that tuberculin testing with the slaughter of reactors was the most appropriate course for disease reduction.

This objective was overshadowed by another - to provide a source of inexpensive meat for Arctic communities and the park area. Few animals were tested for tuberculosis, but large numbers of cows and calves were killed to provide the required meat. This type of culling reduced the most productive sections of the population, the cows and the younger animals that would eventually become the breeding stock. Many disease-free animals were killed. This drew considerable criticism from the public who were becoming more aware of environmental issues and the national park concept, and the program was terminated in 1962.

In 1962, anthrax occurred for the first time in the Hook Lake area, east of the Slave River, and by 1964, it had spread to the Hay Camp and Lake One areas in the park. An intensive disease control program was implemented between 1963 and 1977. It consisted mainly of the periodic culling of the herds and an anthrax vaccination program, requiring round-ups and the use of corrals, squeeze chutes and wing fences.

In 1968, another management program was proposed. This proposal involved a number of corral systems and an annual test, vaccinate and slaughter plan. At the end of a 5-year program, all animals were to be enclosed in corrals or eliminated, and it was estimated that within 10 years, no infected bison would remain. This proposal was rejected for the following reasons:

- (a) cost;
- (b) the bison were a national park asset as they represented the largest free-roaming herd in the world;
- (c) the impossibility, within reasonable expenditures, of locating and eliminating bison remaining outside the fenced enclosures; and
- (d) anticipated criticism from local to international levels.

In 1972 and 1975, proposals were made to develop an integrated disease-control and herd management program; however, all of these efforts were terminated in 1977, in part because of high cost, high stress levels in the animals during capturing and corralling, and public criticism. This marked the end of intensive disease-control management programs in the park.

SIGNIFICANCE OF WOOD BUFFALO NATIONAL PARK:

Most of the bison of concern to the Task Force inhabit the 44,800 km² of Wood Buffalo National Park. The park is widely known primarily because it contains the nesting grounds of the endangered whooping crane as well as more than 4200 bison, the largest free-roaming, naturally regulated herd in existence. The international significance of the bison herd was recognized when the park was

designated a World Heritage Site by the United Nations. The park is also recognized internationally for its role in wetland conservation. There are two Ramsar sites or "Wetlands of International Importance Especially as Waterfowl Habitat" in the park. These sites are the Peace-Athabasca delta and the whooping crane nesting area.

DISEASES AFFECTING THE WBNP HERDS:

The bison populations in and near WBNP are infected with tuberculosis and brucellosis, and the environment is contaminated with anthrax; all are classified as "reportable diseases" under the Animal Disease and Protection Act, and Agriculture Canada must, by law, be informed of any occurrence.

Anthrax

Anthrax is an infectious, fever-producing disease of warm-blooded animals caused by the bacterium Bacillus anthracis. It is characterized by a rapidly fatal septicemia. In seven outbreaks in the WBNP area over the last twenty-five years, a total of 1100 bison deaths were attributed to anthrax. As this disease is soil-borne and the spores survive indefinitely, there is little that can be done to eliminate it once a range is contaminated. The disease is not harboured by the bison themselves. Anthrax was discussed but not considered in detail by this Task Force because it does not significantly affect the viability of the herd and because little can be done to eliminate the disease from the environment.

Tuberculosis

Bovine tuberculosis is a progressively debilitating disease in cattle and bison caused by the bacterium Mycobacterium bovis.

Various species of Mycobacterium may produce the disease in many species under conditions of special exposure, but eliminating infection in the primary host eliminates further infection in the other species.

Mycobacterium bovis in bison may cause pneumonia, lymphadenitis, encephalitis, generalized TB, renal, hepatic or splenic TB, metritis and orchitis. The resulting debilitation in bison makes them more susceptible to predation or the disease may progress to cause the death of the animal. It contributes to poor herd viability by the direct and indirect death of adult bison, by reduced fertility in sexually mature animals, and by birth of infected calves that die soon after birth.

The organisms are excreted in the exhaled air, sputum, feces, milk, urine, vaginal and uterine discharges, and discharges from open peripheral lymph nodes. The organism survives for variable periods of time in the environment. Transmission can occur by inhalation, ingestion (infected milk to the calf, contaminated pasture, forage or water), coitus or congenital infection.

Treatment or vaccination of livestock is not effective in eradicating the disease.

Brucellosis

Brucellosis is an infectious disease caused by the bacterium Brucella abortus. It is known as contagious abortion in cattle and undulant fever in man.

As with tuberculosis, brucellosis may infect a wide range of species under conditions of special exposure, but eliminating the disease in the primary host effectively eliminates further infection in the secondary hosts.

Brucellosis in bison is characterized by abortion and infertility. Abortions, weak calves that die shortly after birth, retention of placenta, metritis, orchitis, epididymitis, arthritis and synovitis all occur.

The organism is excreted with the contents of the pregnant uterus, the fetus and the fetal membranes. Transmission occurs by ingestion (infected pasture or water or milk from an infected dam), penetration of the intact skin or conjunctiva, and contact with aborted fetuses or infected newborn calves. Congenital infection and infection at coitus also occur. The organism survives for long periods of time in the environment and freezing permits almost indefinite survival.

Treatment is ineffective. Vaccination will reduce the incidence of brucellosis, but interferes with its eradication.

Populations at Risk

The populations at risk from exposure to bovine tuberculosis and brucellosis include bison, cattle and people.

Bison in the area include the Mackenzie Bison Sanctuary herd of more than 1600 disease-free wood bison. This population is growing at a rate exceeding 20% annually and is expanding its range rapidly. Small herds of wood bison, part of the Wood Bison Recovery Program, also range at Hay-Zama lakes, Alberta (under fence) and in the Nahanni-Liard River areas. There are also 250 plains bison on a ranch north of Fort Vermilion and another bison ranch has been proposed for the Slave River Lowlands.

There are two small cattle operations in the area, one on Ryan Island adjacent to WBNP and a small herd at Hay River. In the Fort Vermilion Agricultural Zone, there are approximately 6000 head of cattle. The Fort Vermilion Grazing Lease accepts 2000 head of cattle from as far as Provost, Camrose and Ardrossan.

People from Hay River, Fort Resolution, Fort Smith, Fort Chipewyan, and Garden River to Fort Vermilion are at risk, particularly those who hunt, butcher under field conditions, and consume bison, and wildlife officials who come into contact with the animals.

Control

These diseases in bison are similar to infections in cattle. Research has verified that both Mycobacterium bovis and Brucella abortus may be transmitted from cattle to bison and bison to cattle. Agriculture Canada regards domestic bison as part of the national cattle herd.

Other than the Canadian hybrid bison population, there are no known bovine tuberculosis infections in free-roaming wildlife in North America. Brucella abortus is only known to occur in the plains bison of Yellowstone National Park and in elk on the Wyoming elk feeding grounds.

Control in a herd requires the removal of infected animals, prevention of the spread of infection, and avoidance of further introduction of the diseases. Both diseases can be latent, and although a few cattle herds have been cleaned up by test and slaughter procedures, herd depopulation is necessary in most cases. Complete eradication of one or both of these diseases in livestock has been accomplished in several countries in the world and is virtually complete in Canada.

Impact

(a) Agriculture

Agriculture Canada has been working to eliminate tuberculosis since 1907 and now predicts that Canada will be declared tuberculosis-free by December 1989. The brucellosis eradication program began in 1929, and Canada was declared brucellosis-free in 1985. In 1978, Agriculture Canada estimated that failure to control and eradicate these diseases from the national cattle herd would result in a cumulative economic loss to Canada of \$1 billion in the following twenty years.

To maintain the status quo while the rest of Canada is free of tuberculosis and brucellosis requires at a minimum that Agriculture Canada continue surveillance of northern Alberta to verify infection is not spreading from the WBNP area. The current level of surveillance costs about \$500,000 per year.

At the federal level, agriculturalists are concerned about the possible export implications of international uncertainty regarding Canada's certification as a tuberculosis- and brucellosis-free nation. The presence of this reservoir of infection undermines efforts toward such recognition. The concern of the domestic livestock export industry with respect to this risk cannot be over-emphasized.

Provincially, Alberta is particularly sensitive to these concerns as it has 40% of Canada's beef cattle, and the value of Alberta's exports of cattle and red meat is measured in the hundreds of millions of dollars. The meat/livestock industry in the province employs more people than any other industry and is second only to the oil and gas industry in dollar revenue.

It is anticipated that agricultural development will continue to encroach on WBNP. The risk to the cattle industry of disease transmission increases as development increases.

(b) Wildlife

There is a real and immediate threat of infection to the MBS wood bison herd. This herd of about 1600 (75% of the world population) is the only well-established, free-ranging herd in existence. Their rapid population growth and range extension could bring them into contact with the diseased hybrids at any time,

resulting in the spread of tuberculosis and brucellosis to the herd and genetic contamination of the endangered subspecies.

The presence of the diseased hybrid bison is also impeding the National Wood Bison Recovery Program as captive populations cannot be turned loose in a large portion of core historic range in northern Alberta and southern NWT because of the danger of contacting infected hybrid animals.

OPTIONS:

This Task Force discussed and considered a wide range of basic strategies for dealing with the present situation. The many possible combinations of the basic options were not considered, and it is recognized that other options may be proposed during public forums. These will require careful consideration at the appropriate time. Should a particular option be adopted and a decision made to proceed, a more detailed and comprehensive examination of the option will be required and will almost certainly be subject to EARP review.

The options discussed by the Task Force were:

- 1) Status Quo
- 2) Wood Bison Recovery and Disease Eradication
- 3) Fencing of WBNP
- 4) Vaccination and Treatment
- 5) Test and Slaughter
- 6) Buffer Zone around WBNP
- 7) Fencing of Domestic Livestock
- 8) Restriction of Livestock and Wildlife from Encroachment of WBNP
- 9) Composite Option Confining Disease to the Park and Implementing a Modified Buffer Zone.

Of these options the following were found not to be feasible alternatives:

- 4) Vaccination and Treatment have not proven effective in eradication of either brucellosis or tuberculosis in livestock or bison.
- 5) A Test and Slaughter program would be ineffective as it would not be possible to capture the entire herd repeatedly.
- 6) The Buffer Zone concept would require an infeasibly large buffer zone to accommodate the rapid long distance movements of bison and to provide a margin of safety for the surrounding populations. It would likely be ineffective in the long-term, but may be a worthwhile short-term measure to protect livestock and wildlife populations at risk of infection from bison in or near WBNP.

- 7) Fencing of Domestic Livestock/Wildlife to prevent contact with diseased hybrid bison would require double fencing to strict standards of all livestock and wild ungulate populations from Great Slave Lake to High Level, then east to, and south around WBNP. This would be extremely difficult to monitor and enforce, and livestock owners would probably be uncooperative.
- 8) Restricting Encroachment of Livestock/Wildlife on WBNP would require a prohibition on the raising of livestock in the defined area and removal of any livestock presently there.

In addition, none of these five options addresses the objective of reintroducing wood bison to their original range.

The following options were considered in more detail:

- 1) Status Quo.
- 2) Salvage of wood bison stock from WBNP and/or addition of wood bison from Elk Island National Park and the Mackenzie Bison Sanctuary to form the nucleus of a disease-free breeding herd that will ultimately replace the diseased hybrid herd in the park and the Slave River Lowlands.
- 3) Fencing WBNP.
- 9) A composite plan to confine the diseases to WBNP by a combination of strategically placed fences, buffer zones with active bison elimination, and further disease and population dynamics research.

The Status Quo may be the most politically expedient option. It would appear to maintain a situation that has existed for 50 years and would not require any drastic management action or direct expenditures. It would not result in immediate public criticism from environmental, conservation or native lobby groups.

However, preservation of the Status Quo would necessitate action by a number of agencies to protect their own interests. For example, the GNWT would be required to protect the MBS wood bison herd and to deal with current negotiations to establish bison ranching on the Slave River Lowlands in light of the continuing disease problem. They would also likely take action to improve the health and viability of existing bison herds in the NWT, in spite of the presence of disease, by accelerated release of disease-free animals, predator control or other means. Alberta Forestry, Lands and Wildlife would have to re-evaluate their Wood Bison Recovery Program and their plans to release captive satellite herds. Agriculture Canada would, at a minimum, be required to maintain their present disease surveillance of northern Alberta. Alberta Agriculture may have to reassess agriculture and game farming development in the area. Canadian Parks Service and Agriculture Canada would be under increasing pressure from livestock producers and international health organizations. Health and Welfare Canada would have a continuing concern for native health in this area.

Of the options reviewed, the Wood Bison Recovery Option is the only one that addresses all of the agencies' objectives and resolves a majority of their concerns. This option involves a search for and capture of bison indistinguishable from the

recognized wood bison phenotype from WBNP and the Slave River Lowlands, thus saving important genetic resources to augment a presently limited wood bison gene pool. If any animals of this nature were identified, they would be tested for brucellosis and tuberculosis, and those found to be infected with either disease would be destroyed. The disease-free animals would be retained in corrals to form the nucleus of a disease-free breeding herd with the addition of other animals imported from either Elk Island National Park, the MBS or both. In the meantime, all other bison in the area of concern would be systematically eliminated over a number of years. Once there is a high degree of certainty that the diseased hybrid bison have been eliminated, the corralled wood bison would be released to repopulate the area of concern. This option would be a major wildlife management decision. It would receive considerable national and international attention and may create concern on the part of the environmental lobby groups and native organizations. Implementation of this option may take several years and would require a carefully thought out multi-agency implementation plan.

The Fencing Option may be accepted quickly by the public as a way to preserve the bison herd in WBNP. It will probably provide an acceptable solution for livestock producers but may alarm environmentalists and native organizations. The option involves double fencing the 1160-km perimeter of WBNP and eliminating all hybrid bison outside the park. Fencing WBNP would be very expensive, and extreme difficulties would be encountered in building across lakes, rivers and muskeg. Fence maintenance is crucial and would be costly and difficult. The effectiveness of this option depends on maintaining the fence intact. Once all hybrid bison outside the fence have been removed, the objectives of most of the agencies will have been addressed. However, the basis of their concerns will remain as long as diseased bison can escape from the park as a consequence of natural events such as forest fires, or other accidental or deliberate action resulting in a break in the fence.

The Composite Option may also be politically sensitive. Environmentalists and native organizations may protest the elimination of bison from the buffer zone surrounding the park, livestock producers may doubt that their international position would remain uncompromised, and as with the Status Quo, other agencies would have to change policy to protect their interests. Concerns about public health would not be addressed. A buffer has never been used successfully to control movement, and in this case, disastrous consequences result from failure. Should the MBS herd become infected, so many animals over such a large area would be infected that future solutions may be impossible.

All of the foregoing options, except the Status Quo, require the timely development of an interagency implementation strategy for the area of concern setting out the roles and responsibilities of the agencies participating in the solution of this problem.

ENVIRONMENTAL ASSESSMENT AND REVIEW:

It is the policy of the Canadian Parks Service to maintain wildlife populations as naturally regulated elements of the ecosystem. Minimal intervention is allowed however in situations where neighbouring lands may suffer serious adverse effects, public health is threatened, or natural processes have been altered by man and intervention is required to restore the balance. The WBNP bison disease problem presents all of these critical elements.

Any management action on the scale required here, by the Canadian Parks Service or indeed any other federal department, either directly or through provision of funds, will be subject to the Environmental Assessment and Review Process and will require public review.

THE NEED FOR ACTION:

The urgency of the present situation and the need for comprehensive bison management is apparent. In the very near future, regardless of the work of the Steering Committee, other agencies may be forced to take steps independently to protect the Mackenzie Bison Sanctuary herd and other herds from contacting the hybrid diseased animals in and near WBNP. It is acknowledged that this contact could occur at any time, and should it occur, the bison disease problem in this area could expand to such proportions that solutions may never be possible.

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Considering the diversity of mandates of the organizations involved and the urgency expressed for action, the Task Force has managed to compile this document with a high degree of unanimity, which made the task easier and considerably more pleasant than it might have been.

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1.0 INTRODUCTION

The Bison Disease Task Force has prepared this report to describe the past and present state of the bison disease problem in the Wood Buffalo National Park (WBNP) area and to outline a number of possible options available to the Steering Committee and the participating agencies in dealing with the problem and its wider and longer term implications.

The means by which the Steering Committee evaluates these options and any others that come to light is strictly their prerogative. The Task Force co-chairmen briefly examined the possibility of preparing an evaluation matrix on which the Committee could base its deliberations. It quickly became apparent that the further participation of each agency was necessary to design and apply a fair weighting and ranking system for the elements to be considered and for a fair assessment to be made of how well a particular option met each agency's objectives. The Task Force co-chairmen agree however that this technique would provide an objective means of comparing the options.

The Task Force believes that the first step in implementing any solution to these concerns is the development of an interagency strategy for the area of concern in which all participating agencies jointly agree on their respective roles and responsibilities.

1.1 Problem Statements

South of the Mackenzie River in northern Canada, a population of free-roaming bison ranges over a large area in and near WBNP. These animals are the hybrid descendants of the original wood bison of the area and a large number of plains bison infected with tuberculosis and brucellosis that were shipped north from central Alberta between 1925 and 1928.

This movement of plains bison into wood bison range has created two immediate problems. They are:

- (a) that the free-roaming hybrid bison in and around WBNP are infected with the reportable diseases of tuberculosis and brucellosis and as a result may spread these diseases to livestock, other wildlife, and man; and
- (b) that the free-roaming hybrid bison in and around WBNP may interbreed with the wood bison from the Mackenzie Bison Sanctuary (MBS) or other free-roaming wood bison herds that may be established in the area, causing genetic contamination of the endangered wood bison.

Stated specifically, and in keeping with the objectives of the participating agencies, these problems include:

- the potential for the infection of domestic livestock and captive bison herds with brucellosis and tuberculosis;
- interference with Canada's credibility in having a brucellosis-free national cattle herd;
- interference with the reintroduction of wood bison and thus the eventual delisting of wood bison from its current endangered status;
- the danger to the health status of existing disease-free wood bison herds in northern Alberta and the NWT;
- the threat to the genetic integrity of any free-ranging wood bison;
- the danger to human health, specifically native and non-native users of bison;
- the danger to the health of other wildlife.

1.2 Background

It is believed that the original 748 bison released in the 510 km² of Buffalo National Park at Wainwright, Alberta were free of tuberculosis (Mycobacterium bovis) and brucellosis (Brucella abortus). The majority (716) of these animals were purchased from Pablo and Allard in Montana by the Dominion Parks Branch between 1907 and 1912. By 1921, the bison herd had increased to approximately

8500 animals, and even with an annual cull of 2000, the population continued to increase. In 1925, there were 10,000 bison and 1000-2000 other ungulates inhabiting the park, and the range had deteriorated to the point where it could not sustain this population of grazing animals (Ogilvie 1979).

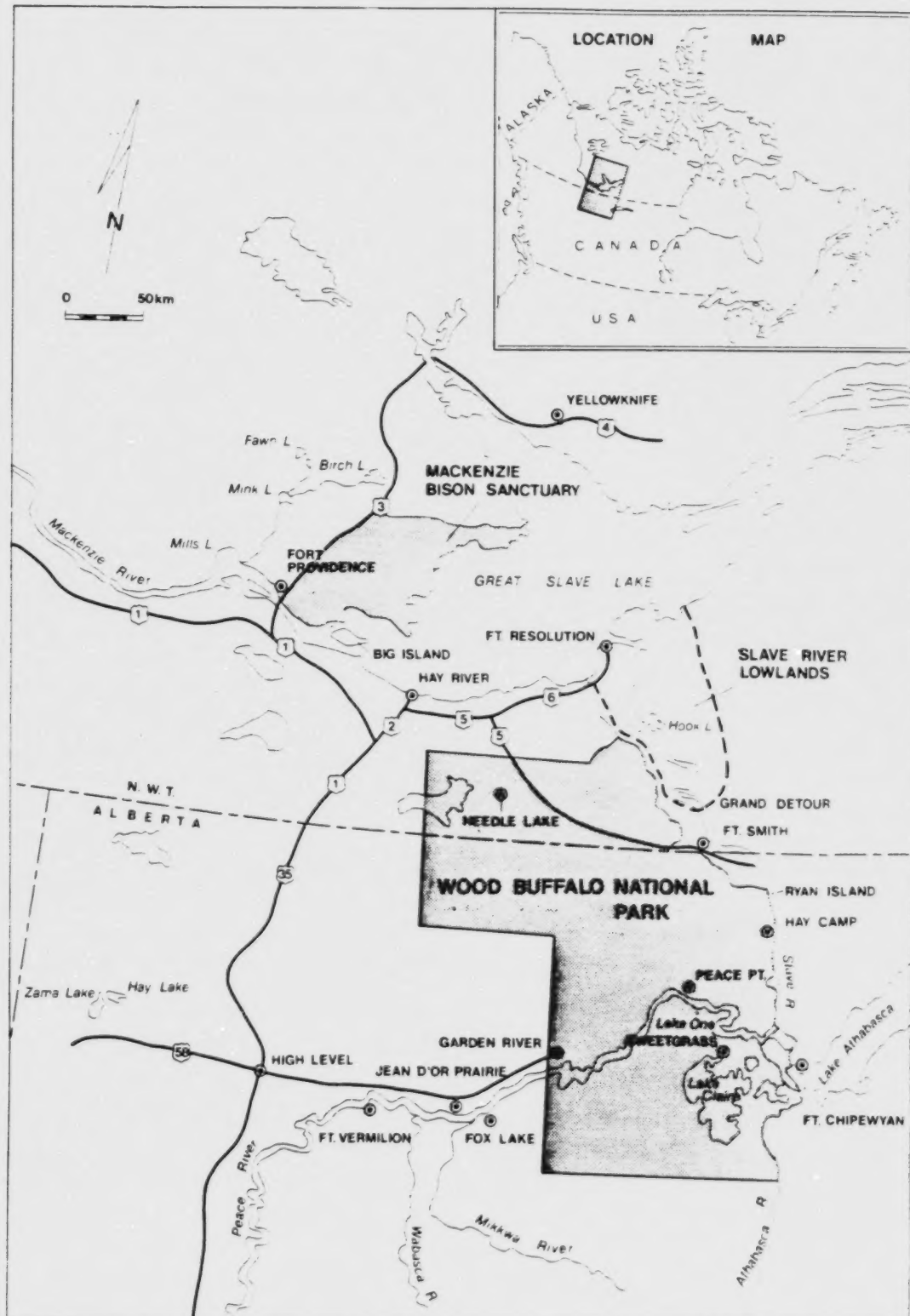
Cattle infected with tuberculosis and brucellosis grazed outside the park, and although efforts were made to separate the cattle from the bison through double fencing, cattalo and certified domestic cattle were often permitted to graze among the bison. Dr. M. Graham, Director of Parks Animals, argued against this practice as he said that it encouraged the spread of disease. By 1917, at least one animal had died of tuberculosis (Ogilvie 1979). The close confinement of more than 7000 animals exacerbated the spread of the disease among the animals in the park.

The reduction of the bison herd by slaughter brought letters of objection from the public, and alternative proposals for dealing with range overpopulation were sought. After lengthy deliberation, it was decided to move surplus animals to Wood Buffalo Park (Ogilvie 1979). This imminent translocation of bison prompted the Parks Supervisor of Wildlife Protection, Hoyes Lloyd, to write the following to the Commissioner of Parks in 1924:

"It is thought to be very bad epidemiology to ship buffalo from a herd known to be diseased and place them in contact with the buffalo at Wood Buffalo Park which are not known to be diseased as far as I am aware."

The caution went unheeded. As a result, this is probably the means by which brucellosis and tuberculosis were introduced into what is now WBNP (Figure 1).

Both diseases are reportable under the Animal Disease and Protection Act, but until recently, the reservoir of disease has been remote from domestic livestock. In the past, individuals and organizations have stated their concerns about the incidence and possible spread of disease from bison in the area to livestock. These concerns on the part of Agriculture Canada, other agencies and the public have increased in recent years as livestock have moved nearer to the park, particularly in the Fox Lake, Jean D'Or Prairie and Fort Vermilion areas.



(after Tessaro in prep.)

FIGURE 1 Area of concern.

1.2.1 Terms of Reference

In 1986, an interjurisdictional steering committee was formed in response to concern about the national and international implications of this large reservoir of tuberculosis and brucellosis in WBNP and adjacent areas. The original Steering Committee was composed of representatives of Canadian Parks Service (CPS) and Agriculture Canada. Other agencies, including Government of the NWT (GNWT), Department of Renewable Resources; Canadian Wildlife Service (CWS); Health and Welfare Canada; Alberta Agriculture; and the Alberta Forestry, Lands and Wildlife Department, were invited to attend future meetings as decisions regarding the bison could affect their jurisdictions. The Committee created a Task Force to review existing information and to evaluate management options. The Terms of Reference for this task force included the following list of duties:

The Task Force will:

1. Determine what scientific, biological, ecological, land use, and other information is required to fully assess the technical and economic feasibility of attaining the objectives of the government agencies identified in the "Report to Steering Committee From Diseased Bison Working Group, Sept. 1986" (Appendix I).
2. Examine the already identified and other possible methods of attaining the objectives of the concerned government agencies, assess and compare the predicted effectiveness of such options, including the status quo, from a technical point of view. Compare estimated costs of delivery of each of the options.
 In addition, the group will assess the acceptability of continuing the present non-intervention management practices and the practicability of implementing any of the various identified options.
 The Task Force should consider and identify the political implications of all options identified but should avoid involving private interest groups in any discussion of options.
3. In a report, concisely and in scientific fashion, summarize and evaluate available pertinent information on wood, plains and hybrid bison, bovine brucellosis and bovine tuberculosis in satisfaction of (1) and (2) and identify additional information required.
4. As an appendix to the report required in (3), present and assess approaches required to fill information gaps identified in (3) and make recommendations detailing research requirements including stated objectives, methodology,

person-year requirements, dollar costs, time required and recommended proponent agency to undertake the research.

For clarity, the Task Group is to assemble available information required to more completely understand historic and existing bison populations, their ecology, the brucellosis and tuberculosis disease implications for wood, plains and hybrid bison as well as domestic livestock and man, and the present intensity, extent and probable future development of livestock operations and game farming in the region.

The above assessments are to include the status quo option.

This report will provide the Steering Committee with information on which to base its recommendations, and should the discussion move to the public forum, it will provide background material for public dialogue or information sessions.

1.2.2 Agency Objectives

The Steering Committee also prepared a list of agency objectives to be addressed by the Task Force. The following objectives were identified:

<u>Agency</u>	<u>Position</u>
Agriculture Canada and Alberta Agriculture	1. Eliminate transmission of diseases to domestic livestock and the perception of its possibility.
NWT Department of Renewable Resources	2. <u>Long Term</u> : prefer to establish a publicly acceptable program that will replace bison south of the Mackenzie with free-roaming, disease-free wood bison.
Canadian Parks Service	3. To ensure that a viable, self-sustaining population bison continues to exist in WBNP.
Canadian Wildlife Service	4. Eliminate the threat of diseased bison interacting with reintroduced wood bison. Eliminate the threat of genetic contamination of wood bison with plains or hybrid bison.
Alberta Forestry, Lands & Wildlife	5. <u>Immediate Objective</u> : To prevent genetic and disease contamination of introduced wood bison west of Hwy 35. <u>Long Term</u> : To introduce wood bison east of Hwy 35 without the threat of genetic or disease contamination.

Health & Welfare
Canada

6. To ensure that people of the NWT, Federal Public Servants and Indian people of Alberta involved in hunting and handling bison are protected from contracting undulant fever and/or tuberculosis.

1.3 Agency Mandates

Given the diverse responsibilities of the agencies involved, the following discussion of mandates and policies is included so that agencies may better understand each other's objectives.

1.3.1 Canadian Parks Service

In North America, the term national park connotes an area set aside as a public heritage or trust to preserve outstanding examples of a nation's scenery, wilderness, geology, natural phenomena or native flora and fauna. Unlike early parks in Europe, Canadian parks were dedicated to public use from their inception.

The national park program in Canada is based on the premise that areas of natural and cultural significance constitute a national inheritance that requires protection.

The national park system in Canada originated when a 10 km² area around the Banff hot springs was set aside in 1885. The Rocky Mountain Park Act of 1887 stated that the area was to be reserved

"as a public park and pleasure ground for the benefit, advantage and enjoyment of the people of Canada."

National Parks Act

The Rocky Mountain Park Act was subsequently replaced by the National Parks Act of 1930. Section 4 of this Act states that:

"The Parks are hereby dedicated to the people of Canada for their benefit, education and enjoyment, subject to the provisions of this Act and the Regulations and such parks shall be maintained and made use of so as to leave them unimpaired for the enjoyment of future generations."

The Act has remained relatively unchanged since that mandate statement.

Parks Policy

Today, this objective is stated succinctly in the Parks Canada Policy manual:

"to protect for all time, representative natural areas of Canadian significance in a system of national parks, and to encourage public understanding, appreciation and enjoyment of this natural heritage so as to leave it unimpaired for future generations." (Parks Canada 1979:)

While it is preferred that both biotic and abiotic elements of the park ecosystem be naturally regulated, section 3.2.3 of Parks Canada Policy (Parks Canada 1979) lists seven specific circumstances in which intensive management practices may be considered. Three of these seven circumstances apply to the bison disease situation. The section states:

"Manipulation of naturally occurring processes such as fire, insects and disease may take place only after monitoring has shown that:

- (i) there may be serious adverse effects on neighbouring lands or
- (ii) public health or safety are threatened or
- (iii) natural processes have been altered by man and manipulation is required to restore the natural balance." (Parks Canada 1979)

Environmental Assessment and Review Process

As with all federal agencies, CPS is subject to the Environmental Assessment and Review Process (EARP). This process was established in 1984 by an Order-in-Council which states that all activities that impact on the environment and in which the federal government is concerned, either through provision of funds or because the project involves federal lands, must be subject to review under EARP (Canada 1984).

Any course of action or option other than the status quo that is chosen to address the bison disease problem in WBNP must be subject to this process.

WBNP Management Plan

The WBNP Management Plan, signed by the Minister of the Environment in 1984, states that WBNP:

"was originally set aside to protect the last remaining herds of bison in Canada. They now form the largest free-roaming and self-regulating herd in the world." (Parks Canada 1984).

One of the major objectives of the park is the protection and preservation of its wilderness character by ensuring the survival of its varied habitats and wildlife populations including such nationally and internationally significant resources as free-roaming bison and the endangered whooping crane (Parks Canada 1984). The plan also states that wildlife resources and the bison herd in particular will be managed by natural "non-intensive" means, and intervention will be permitted only if it is determined that the numbers may decline to dangerously low levels.

The plan also says that:

"To safeguard against threats to public safety and health due to the presence of disease in the herd, existing agreements with Agriculture Canada regarding the Animal Disease and Protection Act will be maintained." (Parks Canada 1984).

Mention is made of interagency discussions regarding buffer zones adjacent to the park boundary.

1.3.2 Agriculture Canada

Agriculture Canada, Food Production & Inspection Branch - Health of Animals and Veterinary Inspection Directorates and Meat Hygiene Division of the Food Inspection Directorate are provided legal authority by the Animal Disease and Protection Act, Animal Disease and Protection Regulations, The Meat Inspection Act, and the Meat Inspection Regulations.

In broad terms, Agriculture Canada is mandated to:

- control or eradicate "Reportable Diseases" in animals as specified by the Animal Disease and Protection Act;
- ensure a safe and wholesome supply of meat and poultry products for trade between provinces and for export to other countries;
- carry out research into animal diseases;
- provide diagnostic and other services; and
- to manufacture diagnostic agents for use in eradicating diseases.

The National Animal Health Program is delivered cooperatively by the Health of Animals and the Veterinary Inspection Directorates. Objectives of the National Animal Health Program are:

- a) to provide a national capability to rapidly detect and eradicate exotic animal diseases which gain entry into Canada;
- b) to prevent the entry of animal diseases or pests associated with importations of live animals, embryos, semen, animal products or by-products;
- c) to provide veterinary certification for the export of livestock, poultry and animal products;
- d) to reduce livestock and poultry losses associated with disease;
- e) to reduce the risk of human illness caused by zoonotic diseases;
- f) to prevent the dissemination of animal diseases in domestic semen or embryos;

- g) to ensure the purity, potency, safety and efficacy of veterinary biologics which are imported, produced in Canada, or exported;
- h) to reduce livestock and poultry losses associated with transportation; and
- i) to engage in international relations to ensure safe import practices and access to foreign markets.

Meat Hygiene Objectives are:

- a) to assure that all meat products produced in Canada are wholesome and properly identified by labels;
- b) To ensure that Canadian products are eligible for export, and that imported meat products meet Canadian standards;
- c) to protect the public against animal diseases communicable to man;
- d) to discourage the development of non-tariff trade barriers;
- e) to improve meat quality (by raising the construction and inspection standards in meat producing plants); and
- f) to increase consumer confidence in meat products (Agriculture Canada (a)).

Relevant Programs*

A. Eradication of Tuberculosis

The purpose of the Bovine Tuberculosis Program is the complete eradication of Mycobacterium bovis and Mycobacterium tuberculosis from the livestock populations of Canada.

This program includes:

- a) postmortem inspection of all animals slaughtered at federal and provincial slaughter plants;
- b) laboratory support - the Animal Diseases Research Institute receives all tuberculosis-like lesions from the slaughter plants and identifies causative organisms;

* Note that by definition in the Animal Disease and Protection Act, bovine (also referred to as cattle and herds) includes buffalo or bison domestically raised or kept.

- c) area reaccreditation - statistical analysis of an area testing program to verify there is sufficient coverage;
- d) area testing - farm-to-farm testing of cattle to provide adequate coverage for reaccreditation or in investigating slaughter plant positives; and
- e) additional coverage is also obtained in testing animals for export or entry to artificial insemination units.

Area tuberculosis reaccreditation is on a provincial basis. It is maintained by submission to Agriculture Canada's Animal Diseases Research Institute of all tuberculosis-like granulomatous lesions, and not less than 1 per 2000 adult cows (24 months of age and older) slaughtered in each slaughter establishment.

A tuberculosis-free province is one in which no case of M. bovis or M. tuberculosis has been diagnosed in the past five years. If a confirmed case of M. bovis or M. tuberculosis is discovered in a free region, this status will be suspended until the infected herd is released from quarantine, and all epidemiological investigations, tracing and testing of contact herds and the testing of herds within a "buffer zone" (not less than 10 km radius) have been completed. If two distinct foci of infection are found in a five-year period, the status will be revoked until a five-year period has elapsed since the last outbreak.

A tuberculosis - accredited province is one in which the number of confirmed cases of M. bovis and M. tuberculosis over the past five-year period has not exceeded 0.2% of the total cattle population of that province. In the event of a level of infection greater than 0.2%, accreditation is suspended until a general test of the province for tuberculosis has been conducted (subsequent to the quarantine and depopulation of all herds known to be infected by M. bovis or M. tuberculosis) that demonstrates an incidence of tuberculosis not exceeding 0.2% of the total number of bovines in the province (Agriculture Canada 1984).

B. Eradication of Brucellosis

The purpose of the Brucellosis Eradication Program is to identify and eliminate Brucella abortus from every species of domestic livestock and, having achieved this, to prevent the recurrence of infection (Agriculture Canada (b)).

This program includes:

- a) market cattle testing - all cows and bulls two years of age and over, sold through public auction, are bled and tested for brucellosis;
- b) brucellosis ring testing - all dairy herds are tested four times a year, by sampling milk and cream at processing plants;
- c) area testing - farm-to-farm testing of herds is done when coverage is lacking for accreditation or when infection is suspected; and
- d) additional coverage is obtained by testing animals for export or entry to artificial insemination units.

According to section 78.1 of the Animal Disease and Protection Regulations (C.R.C., c.296, March 1987):

- 78.1 (1) The Minister may declare a geographical region of Canada to be a brucellosis free region, if in that region,
- (a) the last bovine brucellosis field strain infection identified through epidemiological or bacteriological analysis has been eliminated and,
 - (b) the bovine herd that contained the infection has proved negative to a test for brucellosis performed at least 120 days after the last infected animal has been removed.
- 78.1 (2) The Minister may revoke a declaration under sub-section (1) if he is satisfied that a bovine brucellosis field strain infection has existed in the region for a period of one year.

Similarly section 75 states the criteria for definition of a brucellosis-accredited area:

- 75 (1) The Minister may declare an eradication area or part thereof to be a brucellosis-accredited area for a period of three years if he is satisfied from tests or statistical analysis that,
- (a) the number of bovines affected with brucellosis does not exceed one percent of the number of animals in the area; and
 - (b) the number of affected herds does not exceed five percent of the number of herds in the area.
- 75 (2) The Minister may declare an area referred to in sub-section (1) to be a brucellosis-accredited area for a period of three years if he is satisfied from tests or statistical analysis that,
- (a) the number of bovines affected with brucellosis exceeds one percent but does not exceed two percent of all bovines in the area, and
 - (b) the number of affected herds exceeds five percent but not ten percent of the number of herds in the area,
- if a retest of the affected herds within 120 days shows that there are not more than one percent of affected bovines in the area and not more than five percent of affected herds in the area.
- 75 (3) The Minister may revoke a declaration under sub-section (1) or (2) at any time if he is satisfied that the number of bovines and the number of herds affected with brucellosis exceed the limits set out in sub-section (1).

Export Certification

Agriculture Canada certifies all manner of animals and animal products exported from Canada to the satisfaction of the importing countries. This certification

may include reference to specific tests conducted, quarantine and shipping procedures, disinfection procedures and statements as to Canada's freedom from certain diseases. Canada's ability to claim the status of a brucellosis- and tuberculosis-free nation is of particular significance in this regard. When Canada's freedom from these diseases is recognized by other nations, those nations' requirements for testing may be relaxed or removed completely, reducing the costs of testing to the individual farmer.

1.3.3 Alberta Agriculture

The purpose of Alberta Agriculture is the development and effective management of programs and resources to improve the incomes and well-being of primary producers and those engaged in the processing and marketing of agricultural products and services. One of the objectives of the Animal Health Division is to help protect animal and human health by control, where possible, of the spread of infectious disease in animals and from animals to man. Although it is recognized that brucellosis and tuberculosis fall within the jurisdiction of Agriculture Canada, the presence of bison endemically infected with these diseases in WBNP and surrounding areas is considered to be a significant hazard to livestock populations and human health in Alberta.

1.3.4 Health and Welfare Canada

The following statements describe Medical Services Branch mandates in the Indian Health and Public Service Health Programs.

The overall objective of Medical Services program is to "protect and enhance the health of those Canadians whose care, by legislation, custom, or by Cabinet document, is the responsibility of the Department". (Department of National Health & Welfare Act.)

The principal thrust of this program is to carry out the federal commitment, as expressed in the Indian Health Policy of 1979, to deliver health services to

Canada's Registered Indians and Inuit and to help them attain a health status comparable to that of the rest of Canadians.

Public Service Health is an occupational health program for the Public Service of Canada under authority delegated to the Department of National Health & Welfare by the Treasury Board. Its purpose is to promote occupational health and safety and provide health services designed to ensure the health and well-being of all federal employees, regardless of location, and to minimize the incidence of work-related illness.

Two principal concerns regarding diseased bison in the WBNP area arise from these mandates: the protection of the health of native hunters of these bison and the protection of the health of Federal employees working in the park or with the management of the diseased bison.

1.3.5 Department of Renewable Resources, GNWT

The responsibilities and authority of the department are derived from sections 13 (g) and 13 (h) of the Northwest Territories Act.

These responsibilities are discharged through several acts including the Wildlife Act and the Environmental Protection Act. The Wildlife Act provides for the regulation of hunting, trapping, possession and sale of game, the development and use of wildlife, and the management of species and habitats in the NWT. The department cooperates with federal departments and agencies involved in the broad spectrum of northern environmental and renewable resource management.

The GNWT is empowered to regulate native hunting of a wildlife species if it is in danger of becoming extinct, as defined under the Act. While the wood bison was declared to be endangered under the NWT Act in May 1964, native hunting of the hybrid bison in the Slave River Lowlands (SRL) is unregulated.

13.6 Alberta Forestry, Lands and Wildlife Department

The Alberta Forestry, Lands and Wildlife Department is the agency responsible for the management and administration of fish and wildlife resources within the province, according to the Alberta Wildlife Act and Regulations thereunder. One of the priorities of the department is to identify very rare, scarce or special forms of wildlife outdoor recreational opportunities and to ensure continuing access to these opportunities.

In the Alberta wildlife regulations, plains bison (Bison bison bison) are excluded from the definition of wildlife and are treated as domestic animals. Wood bison (Bison bison athabasca) are defined as wildlife and, more specifically, have been given special status as endangered wildlife. The goals and policies of the Fish and Wildlife Division are delivered through a district office in Fort Vermilion and a regional office in Peace River. The policies of the department with respect to bison are developed by the Wildlife Division in Edmonton.

13.7 Environment Canada - Canadian Wildlife Service

The Dominion Wildlife Service was created in 1947 (changed to Canadian Wildlife Service (CWS) in 1950) under the newly renamed National Parks Service within the Department of Mines and Resources. Its function was to administer the Migratory Birds Convention Act (Canada 1916) and the Northwest Territories Game and Fur Regulations. It was also charged with the responsibility of providing advice and assistance in wildlife management to the Northwest Territories Branch and the National Parks Service (Lothian 1981). With an increase in scientific personnel in the 1950s, CWS broadened its activities in many fields, including investigation and wildlife research. This eventually led to its elevation to the status of a branch in the Department of Northern Affairs and National Resources in 1966. At the Federal-Provincial Wildlife Conference in 1965, a national concern for wildlife had been expressed and a national policy and program were developed which provided for cooperative research and management with the provinces on common problems. Also, guidelines and goals for federal research programs were established, and management of migratory birds and wildlife in

Canada's national parks, in the Yukon Territory, and in the Northwest Territories was emphasized. In 1971, CWS became a branch of the newly formed Department of the Environment, under which it has functioned since then. Presently, it operates within the Conservation and Protection branch of the department.

Legislation and Acts

Enabling legislation that guides the operation of the Canadian Wildlife Service is contained within three acts:

- (a) The Migratory Birds Convention Act (Canada 1916);
- (b) The Government Organization Act, 1970 - Part 1, Department of the Environment Act (Canada 1970); and
- (c) The Canada Wildlife Act (Canada 1973).

The mandate of CWS with respect to this project is defined in the following sections of these acts:

Under section 5 of the Department of the Environment Act, the duties, powers and functions of the Minister of the Environment extend to and include the preservation and enhancement of the quality of the natural environment, including water, air and soil quality, and renewable resources, including the forest resources of Canada, migratory birds and other non-domestic flora and fauna.

The Canada Wildlife Act enables the Minister of the Environment to:

- (a) undertake, promote or recommend measures for the encouragement of public cooperation in wildlife conservation and interpretation;
- (b) initiate conferences and meetings respecting wildlife research, conservation, and interpretation;
- (c) undertake programs for wildlife research and investigation and establish and maintain laboratories and other necessary facilities for that purpose; and
- (d) coordinate and implement wildlife policies and programs in cooperation with the government of the province having an interest therein.

Under section 5 of this act, the minister may, with the approval of the Governor in Council, enter into an agreement with the government of any province to provide for the undertaking of wildlife research, conservation and interpretation programs and measures, the administration of lands for such purpose or the construction, maintenance and operation of facilities and works related thereto. Under section 9 of the act, the minister may, in cooperation with one or more provincial governments having an interest therein, take such measures as he deems necessary for the protection of any species of non-domestic animal in danger of extinction.

Presently, there are three federal-provincial cooperative wildlife research agreements in effect with Alberta, Yukon, and Manitoba for the establishment of wild, free-roaming populations of wood bison in each of those jurisdictions.

Objectives of the Conservation and Protection Branch

Conservation and Protection Branch is charged to conserve, enhance, manage and protect Canada's renewable resources of water, land and wildlife and to influence human activities in a way that will achieve and maintain a state of the environment necessary for the health and well-being of people, the health and diversity of species and ecosystems and for the sustained use of natural resources and the natural environment (air, water and soil). The wildlife research and conservation objective of the branch is to promote wildlife conservation through the conduct of research and provision of advice on the ecology of wildlife other than migratory birds. The CWS national objective for wildlife research and conservation is to promote the rehabilitation and enhancement of threatened and endangered species and to promote the wise, sustained use of wildlife of national and international significance for the economic and social benefit of present and future generations.

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2.0 SPECIAL SIGNIFICANCE OF WOOD BUFFALO NATIONAL PARK

2.1 Introduction

Wood Buffalo National Park (WBNP) is the second largest park in the world and the largest in Canada. It comprises 44,807 km² of poorly drained plain covered by forests, grassland, muskeg, numerous meandering streams, shallow lakes and bogs in northeastern Alberta and southwestern NWT.

Many features contribute to the national and international significance of WBNP. Originally the park was established to protect the few remaining herds of wood bison north of the Peace River. Those responsible for the creation of the park were unaware that a number of biotic and abiotic features, some of which may rival the bison in importance, were included in the original park area and in the area south of the Peace River that was added to the park in 1926.

2.2 Physiography of the Area

Wood Buffalo National Park and the adjacent Slave River Lowlands (SRL) are part of the Interior Plains of North America that extend from the Gulf of Mexico to the Arctic Ocean. The park is also part of the Mackenzie Lowlands, a northward extension of the Great Central Plains (Tempany et al. 1976). Within this region there are large areas of northern boreal forest, expanses of salt plains, extensive areas of wet and dry meadows, and a large freshwater delta formed where the Peace and Athabasca rivers enter Lake Athabasca. Large open meadows combined with areas of mixed deciduous-coniferous forest create a vast region of habitat that supports the world's largest free-roaming herd of bison (Tempany et al. 1976).

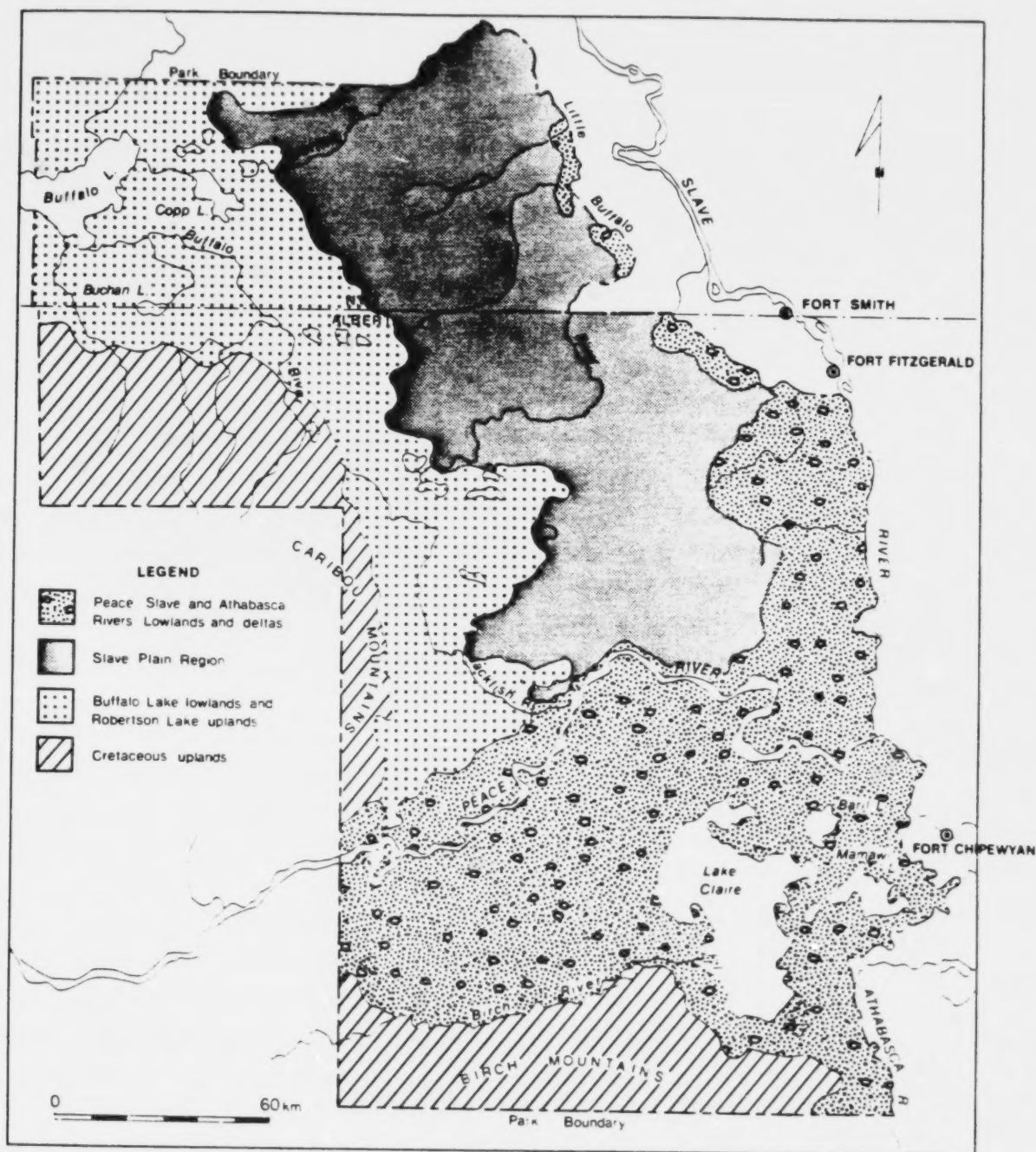
Most of the bedrock in the area is Devonian or Cretaceous limestone and evaporite (such as gypsum) associated with the Interior Plains. A few granitic hills, western outliers of the Canadian Shield, occur along the park's eastern boundary (Parks Canada 1979).

Within the park, the Interior Plains can be subdivided into four distinct regions, shown in Figure 2 (Parks Canada 1979):

- 1) The first region includes the alluvial lowlands formed by the Peace, Slave, and Athabasca rivers and their deltas. These large rivers meander through the low-lying terrain often creating oxbow lakes and terraces or levees along their courses. The Peace-Athabasca delta is a maze of marshes, creeks, and large shallow lakes covering an area of about 900 km². Hundreds of perched basins (higher elevation marshes and lakes) located in the delta area are normally replenished with water during spring floods. However, with declining water levels in the delta and spring floods of reduced magnitude on the rivers, many of these perched basins are no longer being recharged. Vegetation succession is occurring rapidly in response to this drying trend.

In this region, levees along the rivers are the only areas dry enough to support willows (Salix spp.) or mixed forests of white spruce (Picea glauca), aspen (Populus tremuloides) and balsam poplar (P. balsamifera). Interspersed throughout the rest of the delta region of marshes and shallow lakes are large expanses of sedge meadows (Carex spp.) with bulrushes (Scirpus spp.), cattails (Typha sp.) and other emergent vegetation. These extensive wet meadows are poorly drained and usually do not begin to dry until fall, providing lush sedge stands as forage for bison wintering in this region (Tempany et al. 1976).

- 2) In the Slave Plains region in the north-central part of the park, an extensive area of karst topography has developed in gypsum-rich bedrock. The area contains many typical karst landforms including sinkholes, underground caves and stream channels, and springs; its recharge-discharge hydrology is very complex. In this region, large saline prairies are interspersed with small stands of white spruce, larch (Larix laricina) and aspen (Tempany et al. 1976). The meadows are colonized by sedges and salt-tolerant plants.



(after Parks Canada 1979)

SP PNRO 88

FIGURE 2. Physiographic regions of WBNP.

- 3) The Buffalo Lake Lowlands and Robertson Lake Uplands are located in the northwest and central areas of the park, respectively, and together form the third region. This area is underlain by shale containing discontinuous permafrost. Drainage is poor which results in large areas of muskeg, many shallow lakes, and meandering creeks (Parks Canada 1979). The vegetation in this region is usually mixed pine (*Pinus* spp.), spruce, and aspen forest interspersed with muskeg, swampy lakes, and rivers (Tempany et al. 1976). The eastern section of this region is drier and is characterized by extensive stands of jackpine (*Pinus banksiana*), white spruce, and aspen. Part of this region is also referred to as the Upland Boreal Forest section of the Alberta Plateau. This area provides some important summer ranges for bison.
- 4) The fourth region is an area of Cretaceous Uplands that include the Caribou and Birch mountains along the western and southern boundaries of the park. Erosion by rivers has created long incised gorges and large alluvial fans at the base of the plateaus and uplands (Parks Canada 1979). The wetlands in this region are not important range for park bison.

The SRL northeast of WBNP are similar to other lowland areas in the park and consist of alluvial flats bordered by terraces which in turn give way to rolling uplands (Rowe 1972). The highest elevation in the area is 182 m asl. Most of the SRL is underlain by Middle Devonian rocks (gypsum, salt, and limestone), and most of the bedrock is deeply buried under glacial tills (Day 1972; Rowe 1972). The SRL lie within the Upper Mackenzie section of the Boreal Forest region described by Rowe (1972) where white spruce, balsam poplar, and aspen are the dominant forest species. Some of the drier upland sites support jackpine, and black spruce (*Picea mariana*) and larch are prevalent on wet sites (Rowe 1972). Large expanses of open meadows supporting grass and sedge communities dominate the lowland areas, with willow-shrub communities scattered throughout the meadows (Reynolds 1987).

The climate of WBNP and the SRL is continental, and the weather is subject to irregular extremes. This region lies within the cool temperate zone, where cool

summers and long cold winters prevail. Precipitation and temperature are highly variable. From 1943-1975, annual precipitation in WBNP varied from 41 to 46 cm with nearly equal amounts of rain and snow (Tempany et al. 1976); Fort Smith averaged between 33 and 47 cm of precipitation with 40% as snow for the same period (Reynolds et al. 1978). The mean annual temperature for Fort Smith from 1941-1970 was -3.5° C. Mean January temperatures in the southern part of WBNP are below -23° C and in the northern region they are below -26° C. The length of frost-free periods in the park and the SRL range from less than 60 days to more than 100 days in areas that are moderated by large bodies of water (Tempany et al. 1976).

2.3 Significant Natural Features of Wood Buffalo National Park

2.3.1 Salt Plains

The salt plains of WBNP cover over 250 km² and are unique in Canada. During dry periods, mounds of salt over 2 m in height can be found near the salt springs. Salt-tolerant species of plants form a disjunct community which includes a number of species more common in maritime environments.

2.3.2 Peace-Athabasca Delta

The world's finest example of an inland delta occupies nearly 10% of the park area. The Peace-Athabasca delta is a complex wetland created where the Peace, Athabasca and Birch rivers enter the western end of Lake Athabasca. It covers 606,000 ha. and with 19,200 km of shoreline, it is one of the largest deltas in the world.

The delta began to form about 10,000 years ago where the Peace and Athabasca rivers flowed into a depression in the west end of Lake Athabasca exposed by retreating Late Pleistocene glacier ice. Originally, each contributing river formed its own delta, but these have now coalesced. The Peace River part of the delta is no longer being extended; it is considered mature and is largely by-passed by the river except in high flood. The Athabasca River portion is still actively

extending into Lake Athabasca at an estimated rate of 1 km over a 20-km front over a 24-year period (Mackenzie River Basin Committee 1981).

Today four major drainage systems provide water to the delta: The Athabasca River, Lake Athabasca, Peace River and the Birch River. Together, these catchments drain much of northern Alberta, northwestern Saskatchewan and northeastern British Columbia. Before construction of the Bennett Dam, the Peace River controlled water levels in Lake Athabasca and on the delta. At high water, either in spring or after heavy precipitation, the level of the Peace River would rise, blocking normal outflow of the lake and the Athabasca River and ultimately flooding the delta. This regular flooding was extremely important ecologically. Since construction of the dam, Peace River flows have been controlled and peak floods reduced, and many of the perched basins south of the Peace River and north of Lakes Claire and Mamawe have not been recharged. This has resulted in a drying trend on the delta and changes in vegetation and wildlife habitat. In an effort to offset this trend, two submerged weirs were built on Riviere des Rochers and Revillon Coupe. These structures have restored water levels on Lake Athabasca and the delta to near their former levels (Mackenzie River Basin Committee 1981).

The Peace-Athabasca delta is an invaluable regional, national and international resource. It is a crucial link in the Pacific, Central, Atlantic and Mississippi flyways, providing critical staging habitat for a significant portion of the continent's migrating waterfowl population.

The delta contains the largest undisturbed sedge and grass meadows in North America, and these provide prime grazing habitat for many of the park's 4200 bison. The meadows are the subject of plant succession studies as the vegetation communities appear to be changing in response to hydrologic changes in the delta.

The Peace-Athabasca delta has an important cultural history. It was an early transportation hub for the area and now, as it has for hundreds of years in the past, provides a focus for cultural activities and economic opportunities through hunting, trapping and fishing, primarily for the residents of Fort Chipewyan.

2.3.3 Karst Topography

The karst landforms of the park deserve special note as the karst system is one of the largest in the world and contains outstanding examples of collapse sink-holes. The karst area is perforated with small caves and numerous underground rivers, sunken valleys and related hydrological phenomena (Parks Canada 1984).

2.3.4 Peregrine Falcon Nesting Area

The endangered peregrine falcon (Falco peregrinus anatum) nests in the park. The Canadian Wildlife Service (CWS) has worked on the reintroduction of peregrines to this area and at present is undertaking pesticide research on both the eggs and food sources of the birds. Alberta Forestry, Lands and Wildlife and the park are developing an interagency agreement to continue the reintroduction and monitoring studies.

2.3.5 Whooping Crane Nesting Area

The only remaining nesting area in the world of the endangered whooping crane is within the park. Under the protection offered by the park and management by the CWS, this population has increased from 15 birds in 1941 to 130 in 1987, with a number of other birds at the Patuxent, Maryland and the Grays Lake, Idaho sanctuaries in the United States. At present, the park and the National Hydrological Research Institute are conducting research into groundwater in the marl ponds which the cranes appear to favour as nesting sites. CWS and the U.S. Fish and Wildlife Service jointly manage the cranes on their migratory flights, and the United States provides protection for the cranes on their wintering grounds by maintaining the Aransas Wildlife Refuge in Texas.

2.3.6 Evaporation Ponds

The whooping crane nesting area is also the area of major concentration of evaporation ponds. Generally the ponds are shallow and from 0.5 to 25 ha in

size. Few streams flow through the area. The largest part of this system lies between Highway 5 and the Little Buffalo River in the northeast corner of the park. The area is typified by irregularly shaped ponds and nonvegetated areas of carbonate deposits surrounded by black spruce, birch and muskeg. The terrain is flat to depressional with local relief of less than 2 m (Airphoto Analysis Assoc. 1979). At least 50% of this land system consists of open water, the rest is poorly drained. Drainage is internal. Other than some replenishment by precipitation, these ponds are recharged mainly by the underground streams that drain the karst area to the west and by seepage to the surface during periods when the water table is elevated.

2.3.7 Bison

The park protects the largest free-roaming and naturally regulated herd of bison left in existence. Since bison were an integral part of the environment of the interior plains, the landscape is truly complete only where these animals are represented.

As a result of the introduction of plains bison into the wood bison habitat in a ratio of approximately five plains to one wood bison, it is now believed that most of the animals, if not all of them, in and near the park are hybrids through interbreeding of the two subspecies. Through long observation however, some researchers maintain that there are still two morphologically different types of bison in the area (C. Gates, pers. comm.). It is believed that bison in the northern part of the park and in the SRL more closely resemble wood bison, while those in the south are morphologically similar to plains bison.

More importantly, the bison from the park and surrounding area have the broadest genetic base of any bison population in the world. Their gene pool is drawn from much of the former bison range in North America, and as this was the only area from which bison were not extirpated, some of the original genetic material remains. Other herds, both captive and free-roaming, have expanded from relatively small gene pools. Thus the bison in the area and specifically those in the park represent a significant resource for the future genetic diversity and

long-term conservation of bison species. They also represent an important link with the past and the history of the recovery of bison in North America.

Both the Mackenzie Bison Sanctuary (MBS) and the Elk Island National Park wood bison herds were established with animals originally removed from WBNP. In 1957, wildlife officers discovered a herd of 200 wood bison near the Nyarling River that they believed had remained relatively free of contact with plains bison and were ecologically isolated. Detailed examination of these animals led researchers to conclude that they were morphologically characteristic of wood bison, rather than hybrids. In February 1963, 77 of these animals were driven into a corral and tested for tuberculosis and brucellosis. One positive TB reactor and 40 positive brucellosis reactors were found and destroyed; the remainder were held at Fort Smith in a specially constructed holding corral until summer. The presence of tuberculosis and brucellosis in the Nyarling bison herd suggested that the herd probably had some contact with the introduced plains bison. However, subsequent morphometric analysis of cranial and postcranial skeletal data from prehistoric and historic populations confirmed that these animals were more closely related to the original wood bison than the introduced plains bison (Van Zyll de Jong 1986). Based on 11 cranial variables, Van Zyll de Jong (1986) states that the probability of misclassifying the Nyarling River bison skulls as B. b. bison is approximately 5%, which warrants inclusion of this population in the subspecies B. b. athabasca.

Later in 1963, 18 uninfected animals from this population were moved to what is now the MBS and released to form the basis of a new wild herd. Today there are over 1600 animals in the Sanctuary herd. In 1965, 47 more wood bison were captured and tested for disease. After being held in quarantine, 23 were released in Elk Island National Park where, by 1973, they had increased to 200 animals.

2.4 World Heritage Site

The international significance of the resources of WBNP was recognized in 1985 when the park was designated a World Heritage Site by The United Nations Educational, Scientific and Cultural Organization (UNESCO), ranking it with the

Pyramids of Egypt, the Grand Canyon and the Taj Mahal as a feature of international cultural and natural importance.

In the park's World Heritage Site nomination, both the importance of the bison and the significance of diseases in the herd are recognized. The nomination states:

"The park protects the largest free-roaming and self-regulating herd of bison left in existence. The five to six thousand bison in the park constitute the last remnant of the fifty to sixty million bison that dominated the central plains of North America prior to European settlement. As bison are historically an integral part of the interior plains of North America, no other portion of that great landscape is as ecologically complete. The bison help recreate an example of the primeval historical landscape of this continent". (Parks Canada 1978).

and also:

"The possibility exists, however, that some form of intensive manipulation of the bison herd may be required at some time in the future because of the presence of anthrax, brucellosis and bovine tuberculosis on the bison range, or influence of other factors which may significantly decrease the size of the bison population." (Parks Canada 1978).

2.5 Ramsar Site

Wetlands are among the most productive ecosystems on earth, and their conservation is important for biological, hydrological and economic reasons. They provide essential habitat for zootic and botanic species, and they act as sponges controlling and regulating water levels during floods and drought.

In the 1960s, a series of international conferences was held under the auspices of the International Waterfowl Research Bureau in an effort to provide protection against the incursion of man's activities in wetland areas. The Convention on Wetlands of International Importance Especially as Waterfowl Habitat was signed in the Iranian town of Ramsar in 1975. In 1985, there were 36 Parties to the Convention and 294 wetland sites throughout the world covering nearly 20 million

hectares. This international recognition has had significant impact in mitigating development in wetland areas. Two areas nominated by Canada and accepted as Ramsar sites are the Peace-Athabasca delta and the whooping crane nesting area, both in WBNP.

2.6 Summary

The Canadian Parks Service's mandate requires it to carefully and publicly review any major action that may affect the WBNP bison herd. This herd is considered by Canadians to be a very significant heritage resource. It was the stock herd for many of the existing bison herds in Canada today, including the wood bison in the MBS and Elk Island National Park. It is also one of the last herds of bison not presently subject to genetic manipulation, as will likely be the case with most ranched herds in the future.

Nationally, a number of parks and wilderness interest groups have expressed concern over the effect of land claims on the integrity of the park and the impact of additional infrastructure required to create better access to the outside for nearby isolated communities. Other people and agencies outside CPS have questioned the importance of protecting a diseased hybrid bison herd, the hybridization and disease problems of which are a direct result of man's intervention. Internationally, a number of prestigious bodies recognize the park for various reasons. As a result, any extreme management action to deal with the bison disease problem in WBNP would be the subject of considerable attention and would certainly become of interest to the local and national media.

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3.0 HISTORY AND MANAGEMENT OF BISON IN AND NEAR WOOD BUFFALO NATIONAL PARK

3.1 History of Bison in Slave River Lowlands

Samuel Hearne's (1795) account of exploration in the Slave River Lowlands (SRL) east of the Slave River in 1772 provides the earliest record of wood bison in northern Canada. With further exploration by Europeans and the subsequent initiation of the fur trade, the abundance of wood bison near the river travel routes was noted. Soper (1941) estimated that wood bison numbered about 168,000 in the early historic period. The decline of this population and early measures to protect the remaining stock were chronicled by Hewitt (1921).

The once abundant indigenous bison population in the region of what is now Wood Buffalo National Park (WBNP) and the adjacent SRL was reduced to perhaps 300 animals by the late 1800s. The decline coincided with the destruction of vast plains bison herds in southern Canada. The plight of bison was finally recognized in the late 1870s, and formal protective legislation was passed as "The Buffalo Protection Act" of 1877. The act forbade the killing of bison in the last stronghold of the species in northern Canada. However, it was largely ineffectual, and uncontrolled hunting continued until the arrival of the first Northwest Mounted Police in 1907. Further enforcement capability was provided in 1911 when Buffalo Rangers were stationed in the area to discourage poaching.

The wood bison population responded favourably to protection and, by the early 1920s, was estimated to number 1500 to 2000 head (Soper 1941). In 1922, a large portion of the area was set aside as a national park, initially to provide a sanctuary for the wood bison.

Bison were thought to have been extirpated from the SRL or in extremely low abundance there at the time WBNP was established. Bison reinvaded the SRL, probably in the 1940s, as the density of bison increased in WBNP following the introduction of plains bison. By 1949, it was estimated that about 200 animals wintered between the Slave and Talston rivers (Fuller 1950). Novakowski (1957,

1959, 1961) estimated there were 2643 bison in the SRL in 1957, 1300 in 1959, and 1450 bison in 1961. When anthrax outbreaks first occurred in the SRL in 1962 and 1964, the bison population was estimated at between 1300 and 2500 head (Choquette et al. 1972).

Following the discovery of the growing bison population in the SRL in the 1940s, the Slave River Reserve was established to protect the animals and to promote continued population growth. Hunting was permitted after the Reserve status was revoked in 1955. A few animals were undoubtedly taken by General Hunting Licence holders soon after this, and hunting by NWT residents started in 1956. In 1959, two outfitting operations provided guided hunts for sportsmen. When anthrax broke out in 1962, all resident and sport hunting of bison was stopped because of a perceived threat to human health. Anthrax was not observed in the following few years, and a quota of 25 bison was made available for resident hunters in 1968. In 1970, an outfitting business was re-established, and a quota of 25 bison was provided for non-residents who hunted under the auspices of the outfitters. Hunting by native people resident in the NWT was, and remains, unrestricted. The SRL populations declined rapidly during the mid-1970s (see section 3.5.1), and resident and outfitted hunting was terminated.

3.1.1 Current Management Status of Diseased Herds in the Slave River Lowlands

A cooperative research program was initiated in 1974 to examine bison ecology and the potential of the SRL for agricultural development (Reynolds and Hawley 1987). This research indicated that the rapid decline of the SRL bison population, particularly the Hook Lake population, was caused by poor calf production and high mortality due to hunting and predation by wolves. A wolf reduction program was conducted in 1977-78 and 1978-79, but was terminated when lack of public cooperation failed to reduce the number of bison killed by hunters. In 1986, concern about the continued decline of the bison population generated a renewed effort to enlist public participation in bison management. Representatives of native organizations in Fort Smith and Fort Resolution formed the "Hook Lake Bison Management Committee." The Committee proposed to regulate the number

of bison killed by native hunters through public sanctions, rather than by legislation. It was recommended that the wolf population be reduced on the Hook Lake bison range and that surveys be conducted to determine bison population trends, particularly any improvements in calf survival attributable to the wolf control program.

Current management activities for the SRL bison are restricted to population surveys to determine trends, sex ratios, and calf production and survival for bison east of the Slave River.

3.2 Early Attempts at Disease Control

The first occurrence of tuberculosis in park bison was reported in the Fort Chipewyan Mission Diaries in 1937 and 1938. The disease was not reported in the Fort Smith Diaries until 1948, however an animal shot at Fort Smith in 1944 was later found to have had TB.

In 1952-53, an alarmingly high incidence of tuberculosis was noted in the herds, and a heavy culling was recommended to reduce the incidence of the disease. A program of testing and slaughter of reactors (Fuller 1953) was also recommended, but, no testing was actually done until 1956.

It was recognized at this time that if tuberculosis were to be reduced or eliminated, a larger proportion of adult and aged animals, which as a group showed a higher rate of infection than the younger animals, would have to be killed. Also at this time, an apparent decline of caribou populations in the north directed attention to the northern bison populations as a supplementary meat source for native people. This additional pressure and the high incidence of disease made it clear that a long-term bison management program was necessary.

Four long-term objectives for bison management were prepared; the third objective was to reduce the incidence of disease (primarily tuberculosis) and other pathological conditions where possible. It was recognized that the most feasible course for disease reduction lay in a program of tuberculin testing with immediate

slaughter of reactors. It was hoped that reproductive rates would increase as diseased animals were eliminated. Only diseased animals were to be taken in order to achieve a reduction in the incidence of tuberculosis (Stevens 1954).

This management program was in effect between 1954 and 1962. On paper, the principal focus of the program was the testing for disease prior to slaughter. In fact however, much of the culling was an effort to provide meat for northern communities, with little or no selective killing of diseased animals. Many disease-free animals in their breeding prime were killed, and consequently the reproductive rate of the population did not improve. Sampling appeared to be a haphazard event as thousands of animals were captured, but in many instances, no testing for brucellosis and tuberculosis was done despite the opportunities (Tables 1 and 2).

This program drew considerable criticism from the public who were becoming increasingly sensitive to environmental issues and the national park concept. The demise of the program in 1962 was caused in large part by its lack of public acceptance. It was recommended that in future years the objective of disease control to acceptable levels be abandoned, and that selection for slaughter be confined to animals that were in poor condition or that did not take part in breeding.

Before a new program could be implemented, an outbreak of anthrax occurred and became the focus of disease control (Novakowski and Choquette 1961). The epidemiology of anthrax was not completely understood by officials during the first outbreaks of the disease. Since the bison population east of the Slave River was believed to be mostly discrete, (i.e. little interchange took place east and west across the Slave River), government officials theorized that the spread of anthrax from east of the Slave River to bison in WBNP could be prevented by creating a "buffer zone" between the two populations. Therefore, an effort was made in 1964 and 1965 to depopulate the area between the Little Buffalo and Slave rivers. During the winter of 1964-65, 522 bison were slaughtered in that area (Novakowski 1965). The action was ineffective; bison from WBNP rapidly reinvaded the area, and anthrax outbreaks continued to occur, spreading even-

Table 1: Tuberculosis Testing - Wood Buffalo National Park (1947-1974).

YEAR	LOCATION	NO. ANIMALS TESTED	% T.B.	REACTORS OR LESIONS	COMMENTS
1947	Egg Lake Salt Plain Hay Camp	52	4.0	lesions	
1948	Salt Plain				
49/50	Salt Plain 5th Meridian Jackfish River	45	11.0	lesions	
50/51	Fort Smith area Egg Lake	80 40	32.9	lesions lesions	
51/52	Prairie River	218	19.7	lesions	
52/53	Hay Camp	245	45.7	lesions	
53/54	Hay Camp	276	46.0	lesions	
54/55	Hay Camp 5th Meridian	787 21	38.8 40.0	lesions lesions	
55/56	Hay Camp	205	27.4	reactors	
56/57	Nil	-	-	-	Sweetgrass under construction
57/58	Sweetgrass	1065	14.5	reactors	
58/59	Sweetgrass	469	19.1	reactors	
59/60	Sweetgrass	1116	13.5	reactors	
60/61	Field (Lake Claire)	126	46.8	lesions	High water - no disease control. Many old bulls
61/62	Sweetgrass	1854	12.1	reactors	High water - no disease control program
62/63	Field (Lake Claire)	67	41.7	lesions	
63/64	Hay Camp	155	40.0	lesions	
64/65	Hay Camp	152	18.4	lesions	very young and very old missing
65/66	Hay Camp	-	-	-	
66/67	Hay Camp Hay Camp	162 337	30.9 38.9	lesions lesions	337 captured at Sweetgrass and trucked to Hay Camp
67/68	-	-	-	-	
68/69	-	-	-	-	
69/70	-	-	-	-	
70/71	Sweetgrass	197	25.4	lesions	
71/72	-	-	-	-	
72/73	-	-	-	-	
73/74	Sweetgrass	114	21.1	lesions	

Notes - Live animals were tested in only 5 years: 55/56, 57/58, 58/59, 59/60 and 61/62.

Table 2: Brucellosis Testing and Vaccination - Wood Buffalo National Park (1956 - 1974).

YEAR	LOCATION	ANIMALS TESTED	BRUCELLOSIS (%)	No. VACCINATED	COMMENTS
56/57	Hay Camp	11	27.0	-	-
57/58	Sweetgrass	200	35.0	-	-
58/59	Sweetgrass	640	45.0	187 Calves	Live Animals Tested
59/60	Sweetgrass	155	38.1	431 to 2 yrs	Live Animals Tested
60/61	Field (Lake Claire)	75	53.3	-	Many old bulls
61/62	Sweetgrass	-	-	134 Calves	-
62/63	-	-	-	-	-
63/64	Hay Camp	-	-	43 Calves	-
64/65	Hay Camp	143	13.3	-	-
65/66	-	-	-	-	-
66/67	Hay Camp	161 337	15.5 22.2	- -	- 337 Animals Captured at Sweetgrass and Trucked to Hay Camp
67/68	-	-	-	-	-
68/69	-	-	-	-	-
69/70	-	-	-	-	-
70/71	Sweetgrass	164	39.6	-	-
71/72	-	-	-	-	-
72/73	-	-	-	-	-
73/74	Sweetgrass	113	61.9	-	Many old bulls

Notes - Live animals were tested in only 2 years 58/59 and 59/60.

tually throughout the SRL and WBNP. Anthrax mortality statistics for the area of concern are summarized below in Table 3.

Table 3: Bison mortality due to anthrax (1962-1978).

<u>Year</u>	<u>Area</u>	<u>Bison Deaths Attributed to Anthrax</u>
1962	Hook Lake	281
1963	SRL (west of river)	269
	(east of river)	12
1964	Grande Detour	202
	Hook Lake	44
	WBNP	53
1967	WBNP	120
1968	WBNP	1
1971	SRL (east of river)	37
1978	SRL	39
	WBNP	<u>40</u>
	Total	1098

Source: Broughton (1987).

In 1965, an anthrax control program was initiated for bison in the SRL. In addition to the futile attempt to isolate the infected population east of the Slave River, a large corral and handling system was constructed at Hook Lake and a vaccination program was begun. Seven hundred bison were rounded-up and vaccinated in 1965, and in 1966, 557 animals were vaccinated (Choquette and Broughton 1967). Efforts to vaccinate bison annually were reinstituted in 1972 following an outbreak in 1971. Between 1972 and 1975, 1131 bison were vaccinated at Hook Lake. In 1977, the vaccination program was terminated, due in part to concern about the adverse impact of repeated corralling and handling on individual animals and the bison population in general.

3.3 1968 Management Proposal for Wood Buffalo National Park

In 1968, a new management plan was proposed that would restrict the free-roaming nature of the bison (Novakowski and Choquette 1967). In a 39-year period (1928-1967), the population increased only modestly from approximately 8700 to 10,000. This increase was in spite of a probable yearly increment of no less than 8% and no evidence that the herd had approached the maximum carrying capacity of the range. Predator control programs, specifically the poisoning of wolves, were also in effect during this time.

The proposed plan was based on the following assumptions and biological principles (Novakowski and Choquette 1967):

1. "Bison are free-roaming and use the uncultured wild range; there is little or no possibility that the quality of the range would improve or that the productivity of the herds would increase.
2. Mortality factors including slaughters, migrations out of park, disease and floods depress the population and are largely uncontrollable.
3. Low productivity caused chiefly by brucellosis, malnutrition and high mortality do not endanger the population, however, there is substantial waste of a resource.
4. Under Canadian law, the three reportable diseases (tuberculosis, brucellosis and anthrax) should be eradicated if possible.
5. Past disease control management practices have not been effective as only a fraction of the animals were treated, tested or handled in any one year. Furthermore, the animals continued to use infected range and the disease cycle was repeated."

The 1968 management proposal consisted of the following elements (Novakowski and Choquette 1967):

1. "Construction of enclosures at Lake One and Lake Claire and a fenced lane between the two areas for a total area of 262 sq. mi. including both summer and winter range.
2. Provision of enclosures at Hay Camp, Raup Lake and Hornaday River and a fenced lane between the areas for a total area of 236 sq. mi. including both summer and winter range.

3. Round up all animals already in the enclosures and:
 - test each animal for brucellosis and tuberculosis,
 - slaughter all reactors and other undesirable animals,
 - vaccinate all non-reacting female calves against brucellosis, vaccinate all non-reactors with anthrax vaccine, and release these animals into the enclosures.
4. Round up animals from the open range and treat as in 3 above.
5. Test, vaccinate and cull reactors annually."

At the end of five years, all free-roaming animals would be enclosed or eliminated. It was estimated that more than half the bison population or approximately 1000 animals per year for five years would have to be destroyed. The remaining fenced herd would then be culled periodically to maintain the population at a level supportable by the enclosed range. These 4000 animals would be disease-free and would be vaccinated annually for anthrax. (Novakowski and Choquette 1967).

It was believed that within 10 years the park bison range would be brucellosis- and tuberculosis-free, and bison could become free-roaming again; annual round-ups might still be necessary for anthrax control.

It was noted that the gradual elimination of less desirable animals and the removal of the mortality factors could increase productivity by increasing survival.

A need for coordination of bison management activities with the GNWT to control disease outside the park was also identified. The proposal was made to herd as many bison as possible into the park and eliminate the remainder. Implementation of this proposal was planned for 1969-70.

The 1968 management proposal was later rejected for the following reasons:

1. Cost - in addition to the capital and O & M costs for the enclosures, the Sweetgrass abattoir had fallen into disuse and would have to be renovated. There would be massive expenditure with no certainty of success.

2. The bison were a national park asset because they represented the largest free-roaming herd in the world. This value would be lost if the animals were fenced and managed under unnatural conditions.
3. It would be impossible, within reasonable financial limitations, to locate and eliminate bison remaining outside the fenced enclosures.
4. Local, national and international criticism would likely result if a large slaughter occurred.
5. Resistance by Fort Smith - Fort Resolution people to removal of animals from NWT where bison were hunted to provide a source of food.

3.4 WBNP Management Programs 1972-1975

3.4.1 Management Program 1972

Despite rejection of the 1968 plan, there was still recognition that a comprehensive management program was required, and in 1972, an alternative program was proposed by Parks Canada. The proposal was based on the following concerns:

1. "It is not possible to determine from the external appearance of an animal whether or not it has tuberculosis. If a tuberculosis test is given, it cannot be determined if an animal has tuberculosis or has had tuberculosis as both test positive. Further, the more severe the case of tuberculosis the less the chance of a positive test reaction. Susceptibility to the effects of the disease is very low as a female with a severe tuberculosis infection can bear healthy offspring. Since there is no way to establish if diseased or disease-resistant animals are present, it was decided to cease all slaughter programs involving reactor animals and dispose of the Hay Camp abattoir. The abattoir was established to recover costs from the slaughter program, and because of this new program, the structure was considered unnecessary, impractical and inconsistent with evolving National Parks policy.
2. Brucellosis vaccinations were only approximately 75% effective. In some cases, the vaccine itself infects the animal for life. For the vaccine to be effective, it must be given before the animal is nine months old. Even if a female animal has brucellosis, it will only abort once or twice during initial pregnancies. Subsequent births are usually normal although subsequent conceptions may be delayed. For the most part, the disease acts only as a population regulator.
3. As tuberculosis and brucellosis are reportable diseases under the Animal Contagious Diseases Act, it was recognized that by law Parks Canada was required to take all possible measures to control and/or eradicate these diseases. However the Canada Department of Agriculture, Health of Animals Branch, was prepared to take a lenient attitude toward brucellosis and

tuberculosis due to the remoteness of the area and the lack of livestock ranching in the vicinity.

4. National Parks Policy stated that part of the national park purpose is to maintain healthy populations of native animals in balance with their environment. In a natural situation, the balance is accomplished by steady pressure and persistent attrition by predators, natural calamity, parasites and disease.
5. Although the relative isolation of the park and the sporadic nature of anthrax outbreaks did not call for immediate drastic action, it was recognized that a positive program must be developed to control anthrax. In this regard the Department of Agriculture, Health of Animals Branch stated that they would not hold Parks Canada to a vaccination percentage but would permit that which was practical and possible.
6. In view of the above, it became evident that the bison management program would have to be a practical and reasonable approach to disease control. It was decided that the immediate management objective would be to vaccinate as many animals as possible for protection against anthrax and to begin gathering comprehensive herd information to permit the formulation of future management plans.
7. It was felt that if ranching in the area did become a practical proposition in the future, a sufficient body of data would be amassed to permit Parks Canada to determine what action to take concerning treatment and confinement of the herds." (Park Files)

As a result of these considerations, a management program was developed in December 1972 with the long-term objective of developing and maintaining as large a disease-controlled herd as possible. Short-term objectives of the program were:

- to establish procedures for a large scale anthrax vaccination program and to initiate the program;
- to tag each animal handled to help determine migration patterns, incidence of disease, total number of bison, age of animals, etc.;
- to assemble and analyse all information about herd movements, inter-herd exchange, and emigration from the park; and
- to monitor brucellosis and tuberculosis incidence rates.

Past experience had shown the impracticality of driving bison many miles to the Sweetgrass corral site, so it was proposed that a series of small corrals be constructed at strategic locations near migration routes and concentration areas throughout the park. This would allow program managers to be confident that

the majority of the animals had been handled. It would also permit flexibility in the disease control program and a systematic approach to herd information retrieval.

It was considered that this program met with National Parks Policy and the requirements of the Animal Contagious Disease Act and provided, above all, a sound flexible basis for bison management. If necessary, the program could be operated at any reduced level or, in the event of technological advances in the treatment of reportable diseases, the program could be converted easily.

In order to meet the short-term objectives, Parks Canada would:

1. "Construct a series of strategically located corrals along bison migration routes and at gathering points.
2. Begin the annual anthrax vaccination program that would increase the number of animals vaccinated to approximately 80%.
3. Initiate research studies to gather information on migration routes, summer and winter feeding areas, herd interchange, herd structure, and disease incidence, for bison management." (Park Files)

3.4.2 Status of the 1972 Management Program

In order to prevent misinterpretation, the long-term objective was restated in 1975. It read:

"To maintain in a free-roaming state as large a disease-controlled herd as possible within the ecological limits of park resources."

The short-term objectives did not change. They were converted into 5 phases.

- Phase 1 - To assemble existing information on aerial bison surveys with emphasis on regular surveys that have occurred since December 1970 south of the Peace River and since December 1971 north of the Peace River.
- Phase 2 - To continue to carry out aerial bison surveys and to use the data to determine migration routes as well as summer and winter feeding areas.

- Phase 3 - To select corral sites and comment on corral design considerations.
- Phase 4 - To construct corrals and increase anthrax vaccination rate.
- Phase 5 - To design and implement a long-term bison research program.

Phases 1, 2 and 3

In February 1975, Tempany & Cooper (1975) identified 11 possible sites in addition to the Sweetgrass complex where corrals could be constructed. Tentative construction priorities were identified. This report covered Phases 1 to 3 inclusive. The capital cost of building two corrals at or near sites of heavy bison concentration was estimated to be approximately \$469,500 with no consideration of operations and maintenance costs.

Phase 4

Construction of the first corral was to begin in 1975-76, but because of extremely high water levels in the area south of the Peace River from break-up 1973 until freeze-up 1974 (Cordes 1975), the bison population was significantly reduced and traditional bison movements were disturbed. In addition, the high water areas were very close to the first priority corral sites. As a result, construction was postponed until an assessment was made of effects of the Rochers and Coupe weirs on delta water levels.

Extensive damage was done to the Sweetgrass corral complex during the period of high water, and repairs and structural modifications were carried out during the fall of 1975 and early winter of 1976 (Sturko 1976). With the reduced bison population, it was felt that the modifications would permit a larger percentage of the park bison population to be captured annually. The annual anthrax vaccination programs continued at Sweetgrass.

Phase 5 (Research Program)

In April 1975, a technical committee of representatives from Parks Canada and the Canadian Wildlife Service was formed to determine research requirements and

design a program to collect basic data. The technical committee prepared a report "Master Guidelines for a Bison Research Program in Wood Buffalo National Park." An ecological model, bibliographic information regarding population dynamics, range, nutritional requirements, predator-prey relationships, and information on stress during vaccination operations were all identified as requirements.

In 1977, Millette and Sturko (1977) recommended, with the support of the park's Superintendent, that the anthrax vaccination program should be discontinued. The reasons for this recommendation were:

- difficulty in capturing and vaccinating a significant percentage of the park bison population;
- impossibility of detecting small anthrax outbreaks in bison;
- high cost of the program vis-a-vis the number of confirmed deaths due to anthrax in the park;
- high cost of new corral construction combined with no guarantee of ever containing anthrax outbreaks;
- the short-term nature of the anthrax vaccine with a resultant requirement for annual vaccinations;
- documentation of harassment stress and mortality during round-ups; and
- criticism directed to the park by people questioning the validity of vaccination program.

The anthrax vaccination program was the backbone of the 1972 Management Program. The cancellation of this part effectively put an end to the entire program, to efforts to have a 'free-roaming...disease-controlled herd' at the park, and to a number of coordinated efforts to gather information on the bison. The annual round-ups were terminated in 1977, and the capital infrastructure either disassembled over the intervening years or left to deteriorate.

3.5 Natural History of Bison in the Area of Concern

3.5.1 Bison Population Trends

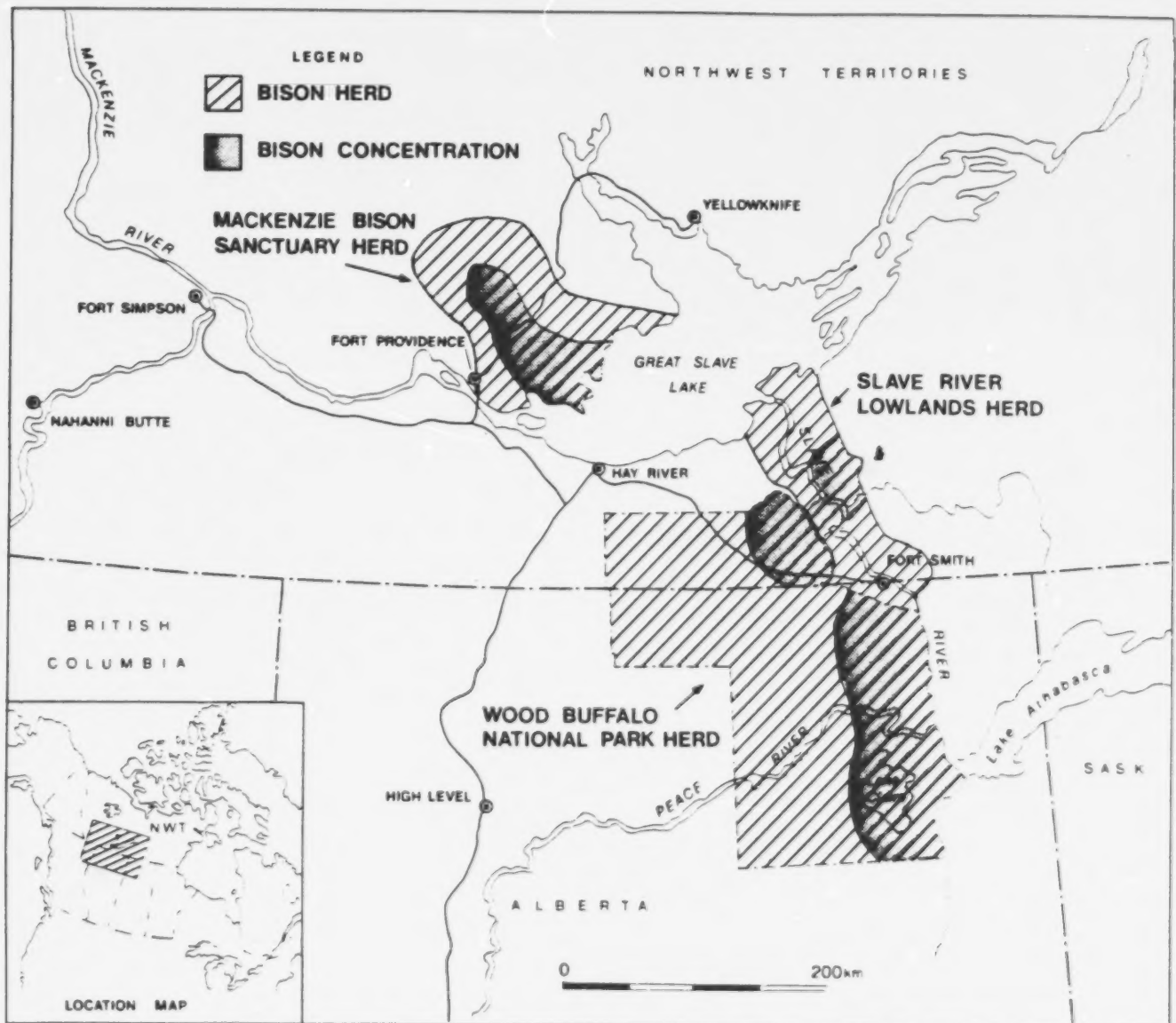
In northwestern Canada, three major populations of wild, free-ranging bison exist, namely the WBNP herd of between 4000 and 5000 animals, the SRL-Hook Lake herd of less than 200, and the Mackenzie Bison Sanctuary (MBS) herd of more than 1600 (see Figure 3) (Reynolds and Hawley 1987).

Wood Buffalo National Park Herd

Wood Buffalo National Park was established in 1922 as a preserve for the protection of the remaining wood bison in northern Canada. This northern population increased from an estimated low of about 300 animals in 1881 to between 1500 and 2000 at the time the park was created (Ogilvie 1893; Seibert 1925; Raup 1933). However, during the period 1925-1928, the introduction of 6673 plains bison from Buffalo National Park at Wainwright, Alberta led to immediate mixing and interbreeding with wood bison in the area of introduction. After the influx of plains bison, the total number of bison in WBNP increased at an accelerated rate to approximately 12,000 by 1934 (Soper 1941).

Population estimates between 1934 and 1972 varied considerably; between 10,000 and 12,500 animals in 1949 (Fuller 1950), between 8000 and 12,000 during the 1950s and 1960s (Novakowski 1961), and approximately 9200 in 1972 (Carbyn et al. 1987). In 1972, systematic aerial surveys were initiated in WBNP to obtain total counts of bison; prior to that time, estimates were based on partial coverage surveys and may not have been accurate (Reynolds and Hawley 1987).

The first recorded decline occurred in the 1972-1975 period when the population on primary ranges in the park (80% of total) dropped from approximately 8700 animals in 1972 to about 4300 in 1975, an estimated 50% decrease (Stelfox and Kingsley 1976). Extensive flooding in the delta during the summer of 1974 resulted in high mortality (as many as 3000 bison may have drowned) and



(after Reynolds and Hawley 1987) SP PNRO 86

FIGURE 3. Location of three major free-ranging populations of wild bison in northern Canada.

complicated analysis of the downward trend. By 1975, the total park population had been reduced to about 5500.

From 1977 to 1985, total count surveys in March of each year indicated that the park bison population fluctuated between 4200 and 5500 (Morrison 1985). The 1982-1985 estimates indicated a gradual but steady decline. The monitoring program indicates that two major trends are occurring in the park bison population, a decline in total numbers and decreasing recruitment (Morrison 1985).

Wood bison, as a genetically separate species, were believed to be extinct in WBNP by 1950; however, an isolated population of bison were discovered in the Nyarling River and Buffalo Lake area in the northwest corner of the park in 1957, and based on detailed measurements of collected specimens, Banfield and Novakowski (1960) described that herd as morphologically characteristic of wood bison. A decision to save the wood bison from possible extinction led to the current National Wood Bison Recovery Program (Reynolds et al. 1982). The majority of the remaining bison in WBNP are now considered to be hybrids.

Slave River Lowlands Herd

The SRL population is believed to have originated during the 1940s when bison emigrating from WBNP reinvaded ranges east of the Slave River in the area north of Fort Smith (Van Camp and Calef 1987). By 1949, it was estimated there were approximately 350 bison in the entire SRL, about 200 of which wintered on the east side of the Slave River (Fuller 1950). Based on 25% coverage surveys of the SRL, population estimates were 2643 bison in 1957 and 1300 in 1959 (Novakowski 1957, 1959). In 1961, the bison population was estimated at 1450 and between 1300 and 2500 when anthrax outbreaks occurred in 1962 to 1964 (Choquette et al. 1972). Surveys made in 1966 and 1968 were increased to 50% coverage. Total coverage surveys were initiated in 1971 and were carried out annually from 1974 to 1985. In 1986-87, a total count was carried out east of the Slave River.

The SRL bison population increased from approximately 350 animals in 1948 to more than 2000 by 1971. However, a decline that began in 1971 has never been

reversed. During the severe winter of 1974-75, the population on the east side of the river (Hook Lake herd) was reduced by approximately 33%. From March 1974 to April 1983, the estimated population of the Hook Lake herd fell from 1904 to 354 animals. Although the rate of decline lessened after the major loss in 1974-75, this general trend has continued for 16 years. The Hook Lake herd is a group of diseased hybrid bison that appears to be nearing extirpation. Only 183 bison were observed during the March 1987 survey (C. Gates, pers. comm.).

The Mackenzie Bison Sanctuary Herd

The third major population of bison in northern Canada is the wood bison herd in the MBS. This herd was established in 1963 by the transfer of 18 animals from the Nyarling River herd in WBNP to an area northeast of Fort Providence, NWT (Novakowski 1963). Sixteen wood bison survived the move (C. Gates, pers. comm.). The MBS population increased steadily to 100 animals by 1971, more than 600 in 1979, 1200 in 1984, and more than 1600 animals in the April 1987 census (C. Gates, pers. comm.). The introduced herd has increased exponentially at a rate of approximately 24% per year (Calef 1984), considered to be near the maximum rate of increase possible for bison under natural conditions in northern environments. The overall trend in the MBS wood bison herd has been continuous numerical growth accompanied by range extension, mostly to the west, south, and southeast beyond the boundaries of the sanctuary. In this region, range expansion has doubled the area presently occupied by wood bison to nearly 10,000 km² (C. Gates, pers. comm.).

In 1983, the NWT Department of Renewable Resources, drafted a 10-year plan for the herd (GNWT 1983). That draft has now been revised and published as the management plan for the Mackenzie wood bison herd (GNWT 1987). The management plan supports the use of hunting as a tool to regulate the rate of increase to gradually reach the target population of 7100 wood bison. The target population is the maximum number of wood bison supportable in the MBS based on available forage (GNWT 1987). The MBS wood bison herd is considered to be free of tuberculosis and brucellosis, based on testing and post-mortem examinations of 50 animals (C. Gates, pers. comm.)

As the MBS population expands, concern about potential contact with diseased bison south of Great Slave Lake increases. The distance separating the closest known bison in the MBS and WBNP populations is only about 100 km. Since pioneering bison from the Mackenzie population are more likely to bridge the gap between the two populations, the NWT Department of Renewable Resources has taken measures to prevent the emigration of bison in a southeasterly direction from the MBS. In January 1988, a policy was announced that provides for the establishment of a bison exclusion zone. Under a Wildlife Management Permit, department personnel are directed to kill any bison found within a specified area south of the Mackenzie River and southwest of Great Slave Lake. It is recognized that this is not a long-term solution to the problem and at best this measure will only reduce the risk of infection of the MBS population.

3.5.2 Population Dynamics

Birth Rates

Bison usually conceive for the first time between one and three years of age bearing a single calf; twins are extremely rare. In WBNP during the early 1950s, pregnancy rates varied from 38% of 2-year-olds and 65% of 3-year-olds in the area north of the Peace River to 59% of 2-year-olds and 81% of 3-year-olds in the area south of the Peace River (Fuller 1962). Also, 52% of female bison conceived for the first time as 3-year-olds, but fertility appeared to decline in animals between 12 and 15 years of age (Fuller 1962).

The rate of calf production in wild bison herds is often expressed as a percentage of the total population; however, this can be misleading if sex and age distribution are not considered. It is often impossible to obtain full segregation counts in areas where wild bison exist because of high cost and inaccessibility. In WBNP during the early 1950s, summer observations of bison herds indicated that calf crops (calves expressed as a percentage of the total number of animals observed) were usually 15-20%; a calf crop of 20-25% was the perceived potential for the population during late June and early July (Fuller 1962). The percentages of

calves tended to decline by about 2% per month until December when calves comprised less than 10% of the herd; survival to the yearling category in the park ranged between 5 and 8% per year (Fuller 1962).

Calf crop data for the WBNP and the SRL hybrid bison herds from 1975-1986 are summarized in Tables 4 and 5, respectively.

In general, reproductive success for wood bison in the MBS has been much better than that for the hybrid bison in WBNP and the SRL. Calef (1984) reported calf production rates of 20.7 - 22.3% of the total early summer population in a herd believed to have an equal sex ratio. Assuming a 1:1 sex ratio, Calef (1984) calculated that the exponential rate of increase observed in the MBS could be attained if 90% of the mature cows had a calf every year. With intensive management in captive herds of plains bison these rates are possible; however, in wild bison in WBNP, Fuller (1962) reported that cows normally produced two calves every three years. In the SRL in a year of high calving (1978), only about 50% of mature cows produced calves, and by July, only about 33% of mature cows still had a calf surviving (Van Camp and Calef 1987).

In the MBS, 13 of 19 (68%) mature wood bison females collected over several winters were pregnant (C. Gates, pers. comm.). In November 1984, a calf:cow ratio (cows 2 years of age and older) of 61:100 was observed, the highest rate recorded for this population (C. Gates, pers. comm.). Calf production in the MBS is nearly twice that observed in the WBNP or SRL bison herds.

Table 4: Bison Calf Crop Data - Wood Buffalo National Park.

<u>Date</u>	<u>Comments</u>	<u>Calf Crop (% total herd)</u>	<u>Source</u>
1951-75	review of data for period 1951-75	low 10.8% (1972) high 25.1% (1970) average 15.6%	Tempany 1976
1975	June-September	13-18%	Tempany and Cooper 1976
1976	June yearling crop 12- 14% - indicates good winter survival 1975-76		Tempany and Cooper 1976
	August	12.4%	Millette and Collingwood 1977
1977	February - good winter survival as yearling count in May 1977 was 8.4%	8.9%	Millette and Collingwood 1977
1984	spring late June fall winter	15.2% 16.3% 8.2% 5.2%	Morrison 1985
1985	late June - classified herd count 201 calves to 723 cows or 27 calves: 100 cows	13.0%	D. Huisman, pers. comm.
1986	late June - classified herd count 449 calves and 1423 cows or 31 calves: 100 cows	16.0%	D. Huisman, pers. comm.

Table 5: Bison Calf Crop Data - Slave River Lowlands.

<u>Date</u>	<u>Comments</u>	<u>Calf Crop (% total herd)</u>	<u>Source</u>
1975	May	15.0%	Van Camp and Calef 1987
1976	March Spring	2.0% 18.0%	Van Camp and Calef 1987
1977	January March early summer	10.0% 5.6% 15.0%	Van Camp and Calef 1987
1977-78	December-March	5.0%	Van Camp and Calef 1987
1978	May September December	22.0% 15.0% 11.0%	Van Camp and Calef 1987
1979	March	5.5%	Jalkotzy 1979
1984-86	21-31% of 2-year-old females produced calves; similar to WBNP		C. Gates, pers. comm.

Mortality Factors

In WBNP, wolf predation is considered to be a major cause of bison mortality (Carbyn et al. 1987). Hunting of bison in the park is illegal, and although some poaching does occur, it is not considered to be a significant factor. The high incidence of tuberculosis and brucellosis in park bison may also limit production (Broughton 1987).

The decline in the SRL bison population has resulted from low rates of reproduction, poor calf survival, and poor recruitment to the yearling age class (Van Camp and Calef 1987). These problems are primarily attributable to a combination of three major mortality factors: hunting by humans, predation by wolves, and disease (Reynolds and Hawley 1987). It has not been possible to quantify the individual effects of each of these mortality factors.

In the MBS, the rapid increase of the wood bison population can be attributed to good reproduction and high survival rates in all age classes (C. Gates, pers. comm.). Several factors, including protection from hunting, absence of significant diseases, and a low rate of wolf predation, are believed to have contributed to the continuous growth of this population.

Wolf predation has been identified as an important mortality factor in WBNP (Fuller 1961, 1962). During the 1930s, wolf predation on bison was observed but was not considered to be detrimental to the population (Soper 1941). During the early 1960s, bison formed the staple diet of park wolves in summer and winter (Fuller 1961, 1962), and even though calves and older animals were selectively preyed upon, this was still not regarded as detrimental to the population. During a wolf study in 1979, a pack of 10 wolves killed an average of one bison every 7.8 days from 12 February to 31 March (L. Carbyn, pers. comm.). Similar predation rates were observed in the SRL (Van Camp 1987). Wolves in WBNP appeared to kill selectively older male bison, whereas in the SRL, it appeared that cows and calves were more often killed.

Hunting and predation by wolves are two of the three major mortality factors responsible for the continued decline in the SRL bison population. From 1973 to 1979, hunter kills equalled or exceeded the total annual recruitment of bison (Van Camp 1987). In 1976-77 when the SRL bison population was declining rapidly, the estimated total loss to the adult and subadult cohorts was 191 animals, of which 75 (39%) were attributed to hunting and 60 (31%) were presumed to be caused by winter wolf predation (Van Camp 1987). Therefore, hunting and winter wolf predation together accounted for at least 70% of adult-subadult mortality observed that year. Recreational hunting was discontinued in 1977, and a two-year selective wolf control program was implemented, but the impact of that program was not assessed because it was terminated before completion. However, the bison population continued to decline (Jalkotzy 1979), and SRL bison are still taken by General Hunting Licence holders.

Disease can cause significant mortality in northern bison populations (Fuller 1962, Choquette et al. 1972), either directly or by increasing the susceptibility of the animal to predation. In the SRL and WBNP, it has not been possible to quantify the impact of disease as a mortality factor in the bison populations (Hawley and Reynolds 1987). Qualitatively, disease is considered to be one of the major factors contributing to the decline in the SRL bison population and may be limiting production in WBNP herds (Broughton 1987). Tuberculosis infection rates averaged 36% in WBNP and varied between 25 and 40% in the SRL, while brucellosis infection rates averaged 36% in WBNP and 38% in the SRL (Broughton 1987). The effects in bison can be expected to be similar to those in cattle where tuberculosis can cause an estimated loss of 10-25% in productive capacity in terms of feed efficiency, weight gain, and milk production (Blood et al. 1983). Brucellosis causes abortion and infertility in cattle (Choquette et al. 1978) and recently, under experimental conditions, has been found to cause similar effects in bison (D.S. Davis, pers. comm.). Postmortem examination of 50 wood bison collected in the MBS from 1982 to 1987 and blood tests on 27 captured bison failed to detect either tuberculosis or brucellosis.

Several outbreaks of anthrax in the SRL and WBNP occurred from 1962 to 1978 resulting in the death of approximately 1100 bison from the disease and associated

control measures (Broughton 1987). Anthrax is probably not an important factor in the dynamics of these populations.

Roe (1970) considered drowning to be an important mortality factor in plains bison. Sometimes entire herds were killed (Raup 1933, Meagher 1973). Accidental drowning often occurs as a result of animals falling through thin ice in spring and fall, voluntarily crossing flooded rivers, or being trapped during spring flooding (Reynolds et al. 1982). In WBNP regular annual losses of 40-50 animals by drowning have been reported (Soper 1941, and Fuller 1961, 1962). There have also been periodic losses of large numbers of bison in WBNP from drowning (Mitchell 1976). Spring floods in the Peace-Athabasca delta area of the park caused estimated losses of 500 bison in 1958, 1100-3000 bison in 1960-61, (an estimated 4000 bison were lost over the 10-year period 1957-1967), and an estimated total loss of approximately 3000 bison during the 1974 spring flood. Under such circumstances, drowning can be a significant mortality factor in northern bison populations.

Sex Ratios

The primary (in utero) sex ratio was 53% males in a sample of more than 400 fetuses examined between 1952 and 1956 in WBNP (Fuller 1962). Five herds of plains bison located throughout the United States had similar sex ratios ranging from 51% to 56% males (Reynolds et al. 1982). A slight excess of males in the primary sex ratio is common in mammals (Fuller 1961).

3.5.3 Movement and Distribution Patterns

Bison move frequently either in altitudinal (as in Yellowstone National Park, Meagher (1973)) or directional migrations (as in WBNP). Historically, the general movement of plains bison tended to be in relation to habitat type rather than latitude as they moved into parkland areas in winter from summer range on the prairies (Roe 1970). The timing and distance of movements were likely related to factors such as location of traditional areas of use, availability of forage, water

and shelter, insect harassment, forage quality, and variations in local weather conditions (Reynolds et al. 1982).

In WBNP, Hewitt (1921) referred to distinct northern and southern subpopulations in early times. Later, annual directional movements were identified, and approximately 80% of the bison could be located in predictable wintering areas (Soper 1941, Fuller 1962, Stelfox and Kingsley 1976). Aerial surveys were conducted between 1970 and 1975 to determine areas of concentration and spring and fall migration routes (see Figure 4) (Tempany and Cooper 1976). The same trails and ranges were used repeatedly in a display of traditional use patterns. In the area south of the Peace River, major spring and summer movements occurred from the southeast delta region to the Lake One meadows with a reverse migration in the fall, normally commencing with freeze-up. In spring and summer in the area north of the Peace River, bison moved from Murdock Creek meadows in the southeast along the Slave River to Raup Lake and Salt Plains in the northern part of this area (but still south of the NWT border). This pattern was reversed during fall and winter. Bison movements followed the same general patterns in 1975-76 with only minor shifts in numbers of animals and timing of movements in a few areas (Collingwood and Millette 1977). Traditional trails and ranges were still used, indicating habitual use patterns. Of special note is the recent observation of a herd of 91 bison near Thultue Lake in the west-central area of the park in the Alberta Plateau region during the March 1987 total count survey (D. Huisman, pers. comm.). In the past, only a few solitary animals have been observed in this area.

Transboundary movements of bison in WBNP appear to occur mainly in three areas - along the northeast boundary, in the southeast, and along the Peace River in the southwest (see Figure 5; D. Huisman, pers. comm.). The northeast boundary of the park is formed by the Little Buffalo River, and animals commonly move across the river out of the park into lowlands on the west side of the Slave River. Recently, the number of animals in this region has been declining; only 92 animals were observed during the March 1987 survey (D. Huisman, pers. comm.). Farther south along the Little Buffalo River in the area of Lobstick Creek but north of the Fort Smith highway, bison are occasionally seen outside the park

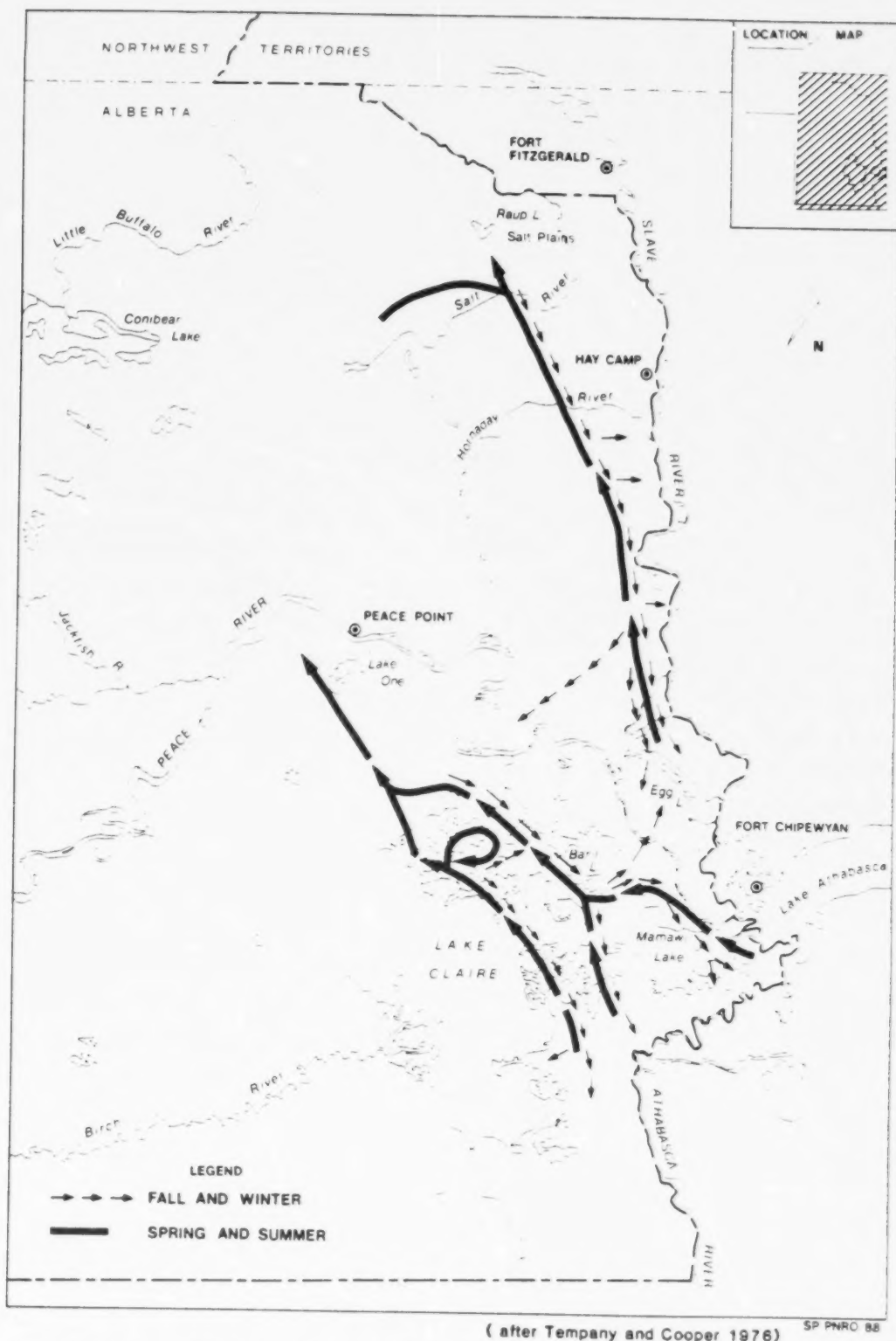


FIGURE 4. Major spring and fall migration routes of bison in Wood Buffalo National Park

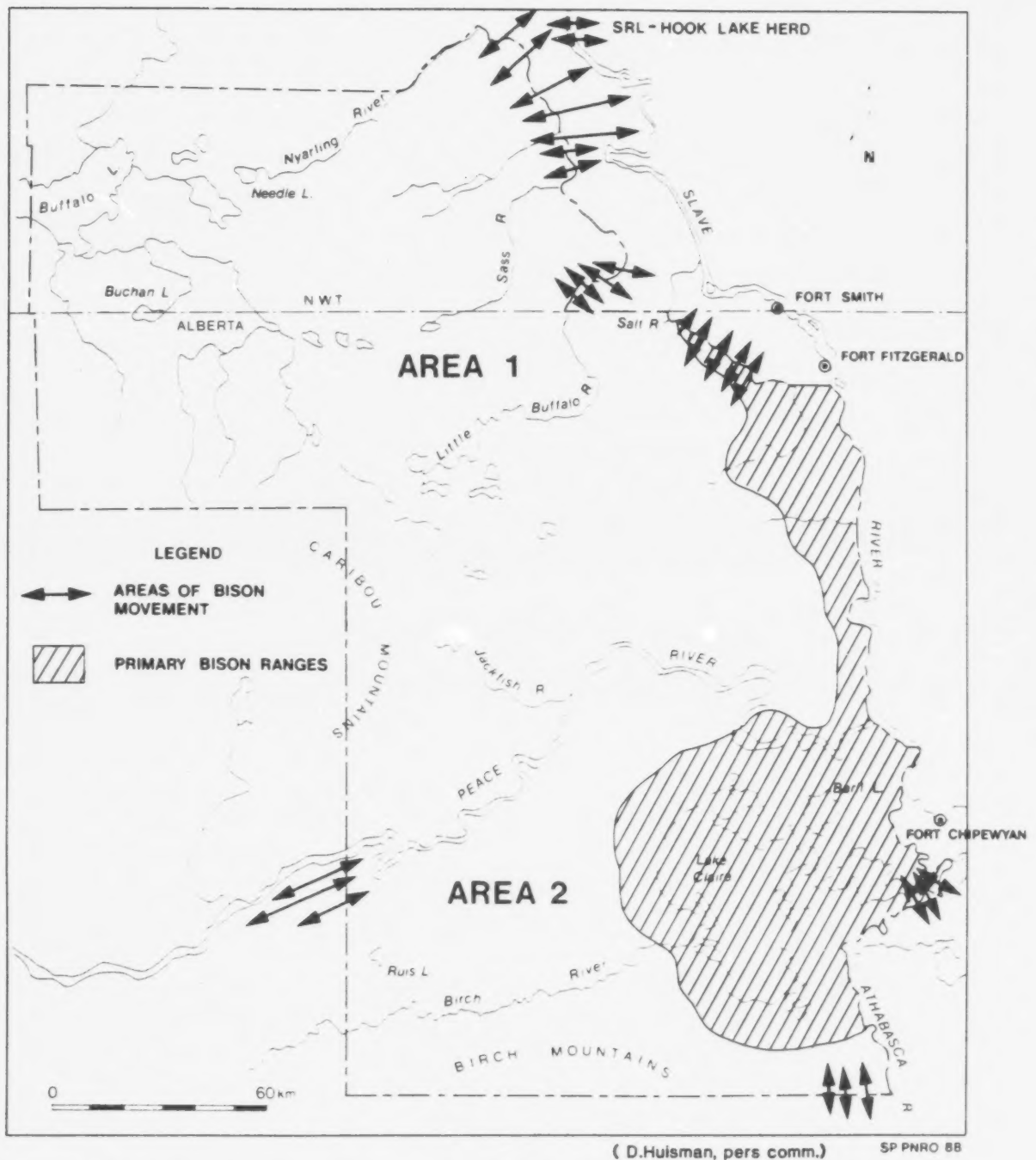


FIGURE 5. Locations of transboundary movements of bison in Wood Buffalo National Park.

boundary. South of the NWT border, bison move out of the park across the Salt River onto provincial land, especially in fall and winter; many of these bison are killed by hunters as soon as they leave the park.

The second area of transboundary movement occurs in the southeast region where approximately 10-20 animals per year leave the park by crossing the Embarras River just south of Lake Athabasca. Most of these bison also are killed by hunters as soon as they cross the river (D. Huisman, pers. comm.) Trappers report occasional sightings of bison near the southeast corner of the park. This area is not used frequently by bison, but in 1984, about 25 animals were sighted on the Firebag River outside the park boundary (S. Tessaro, pers. comm.).

In Alberta, there is very little information about the distribution of bison outside the park on provincial land. It is known that bison frequent Wentzel Lake and the area between the Wabasca and Mikkwa rivers, from township 102 north to the Peace River, southwest of the park. Bison are hunted in this area by native people of the Little Red River band. In the winter of 1984-85, up to 75 bison were shot.

For many years, occasional observations of bison as far west as High Level have been reported to Fish and Wildlife offices. One sighting of a bison was confirmed as far south as the mouth of Cadotte River (18-89-20-W5) (Fish and Wildlife files). Gainer (1985) summarizes observations of bison west of the park and notes that at times there may be as many as 250 bison in the Fort Vermilion area. Observations of bison from Steen River and Buffalo Head Prairie indicate the extent of the area that must be considered in attempts to control the spread of disease.

Bison movements and seasonal distribution patterns in the SRL have been described by Calef and Van Camp (1987). The populations of bison east (Hook Lake herd) and west of the Slave River are believed to be discrete subpopulations with little, if any, interchange. In 1975, 72 adult bison were marked with coloured neck collars at Hook Lake. Collared bison were observed in nearly all parts of the range east of the Slave River during the following three years, but none were

observed west of the Slave River (Calef and Van Camp 1987). However, movement across the Slave River has occurred occasionally and recent reports indicate that it continues (C. Gates, pers. comm.). Generally, movements of bison on the east side of the Slave River tend to be seasonal. Large herds congregate in the north-central part of the SRL range during calving and post-calving periods and then spread out in a more uniform distribution to the west along the Taltson River during the rutting, early winter, and late winter seasons (Calef and Van Camp 1987). The normal winter distribution pattern on the east side of the Slave River was abandoned during the severe winter of 1974-75 when large herds broke into smaller groups that moved farther south than usual; normal patterns were re-established the following winter (Calef and Van Camp 1987). The population west of the Slave River can be affected by immigration of bison from the northeast area of WBNP and emigration to the park.

In 1963, wood bison released into the MBS at a location approximately 20 km northeast of Fort Providence, NWT moved approximately 15 km east to Falaise Lake. From 1963 to 1980, this population remained in the southeast part of the sanctuary using the Falaise Lake area as the major winter range. The herd continued to move into adjacent major lake beds, slowly expanding its range northwestward and beyond the sanctuary boundary. Wood bison were first noticed in the Mink Lake area in 1980, approximately 25 km west of the sanctuary. Since then, the number of animals reported there has increased rapidly to 200 by 1984 and more than 400 by 1986 (C. Gates, pers. comm.). Bison move regularly between the sanctuary and Mink Lake using seismic cut lines and fire control access roads as routes of travel. Colonization of new range appears to be initiated by adult bulls with mixed-herd groups moving in later. It appears that wild fires in 1974 and 1980 created favourable open meadow habitat in this area. Range expansion is expected to continue as these wood bison extend their migrations into adjacent areas of suitable habitat. This may include movements south from Mink Lake into a vast area of wet sedge meadows near Fort Providence and Mills Lake on the Mackenzie River (C. Gates, pers. comm.).

3.5.4 Social Organization and Seasonal Aggregations

Social organization in plains bison has been described for several herds throughout North America; Elk Island National Park (Shackleton 1968), Yellowstone National Park (McHugh 1958; Meagher 1973), and Santa Catalina Island (Lott and Minta 1983). Bison are gregarious animals forming groups of varying sizes. Three main types of groups are most often observed throughout the year - mixed-herd or matriarchal groups (cows, calves, yearlings, and sometimes a few bulls), bull groups (including solitary bulls), and breeding groups which are formed by a combination of the other two groups (Reynolds et al. 1982). Mixed-herd groups vary little in size throughout the year except during the rut when they are joined by breeding bulls and sometimes by other mixed-herd groups to form larger breeding herds. Mature bulls are solitary and seldom form groups of more than a few animals, although bull groups of up to 35 individuals have been observed occasionally in the SRL (Calef and Van Camp 1987).

The social behaviour of hybrid bison in WBNP was described by Soper (1941) and Fuller (1960). The average size for mixed-herd groups was 11 - 30 animals, with considerable variation (Fuller 1960; Egerton, 1962). In forested habitat, herds tended to be smaller, with more than 50% containing only 6-20 individuals (Fuller 1960). On the open sedge meadows north of Lake Claire, herd size was larger with about 66% of the herds containing more than 20 individuals. In this habitat type, herd size varied greatly, suggesting a continuous joining and splitting of herds. However, a basic unit of about 11-20 animals seemed to prevail with the larger herds being established by amalgamation of two or more basic units (Fuller 1960).

In the area north of the Peace River in 1975, spring migrations to calving grounds near Raup Lake and other areas within the Alberta Plateau commenced in early May (Tempany and Cooper 1976). These bison migrated from wintering areas in lowland sedge meadows along Murdock Creek (Figure 4). Other winter ranges in the area of Hay Camp and Darough Creek meadows were used that year as calving grounds (Tempany and Cooper 1976). In the area south of the Peace River during the early 1970s, spring migrations commenced in late April. The

majority of bison moved from lower delta meadows located southeast of Lake Claire to scattered meadows and mixed-forest areas north and west of the delta for calving (Tempany and Cooper 1976). By early summer, the majority of bison in this region returned to drier parts of the delta in the vicinity of Sweetgrass Creek, North Arm, and Lousy Creek (Figure 4). The Lake One area has been an important traditional calving area for delta bison but its use is steadily declining, perhaps as a result of the current drying trend (D. Huisman, pers. comm.). Frequently used calving areas are located along the north and east shores of Lake Claire, where levees at the ends of points or islands in Lake Claire are preferred (D. Huisman, pers. comm.).

The social organization and behaviour of hybrid bison in the SRL were described by Calef and Van Camp (1987). The largest groups of bison were most often found during the post-calving season in the north-central area of the SRL on the east side of the Slave River north of Hook Lake. This area was also the major calving range for this population. Mixed-herd groups attained their maximum mean size of 75 animals when large groups began to form on the open prairies in these post-calving areas (Calef and Van Camp 1987). Herds of nearly 1000 animals were observed twice in the early 1970s during the post-calving season. Mixed-herds tended to disperse as bull groups joined for the rut; these groups became relatively small and widely scattered by the end of the rutting season. This dispersal pattern continued through the post-rut period producing the lowest mean annual group size of 27 animals (Calef and Van Camp 1987). By early winter, the mean group size increased to about 38 animals and remained constant for the rest of the winter. The size of bull groups followed the same trend, reaching the maximum mean size of four individuals during the post-calving period. During the rutting season in the SRL, bison herds dispersed into smaller groups, moved frequently, and selected smaller meadow, shrub, or forest habitat. This behaviour contrasts with the normal breeding pattern reported for plains bison in which maximum group size is attained during the peak of the rut. This dissimilarity may be related to differences in habitat and nutritional status; it may also reflect poor condition and/or stress in the SRL population.

In summary, mixed-herds of bison on the SRL are scattered throughout the range in groups of 20-60 animals for most of the year, while bulls usually form groups of 2-5 individuals. This pattern changes somewhat during the post-calving, rutting, and late winter seasons. The greatest change occurs during the post-calving season when group size doubles and sometimes triples. At this time, which coincides approximately with the insect season, bison are located in ranges containing the most open habitat (Calef and Van Camp 1987).

Some aspects of the social organization of wood bison in the MBS have been described by Larter and Gates (1987). Wood bison were observed in male-only herds as well as in mixed-herds dominated by cows and juveniles. The largest herd aggregations were seen in early summer during the late calving and early post-calving period. Herd size declined during the rut in August and September and continued to decline in October, but then increased during November (Larter and Gates 1987). At the onset of the rut in August, mixed-herds began to disperse from open habitats into forest habitat. Dispersal of mixed-herd groups during the rut is contrary to the typical behaviour of plains bison which aggregate during the rut (McHugh 1958; Meagher 1973; Lott and Minta 1983), but it corresponds well with that reported for hybrid bison in the SRL (Calef and Van Camp 1987). In the MBS, the number of solitary bulls observed during the rut increased which suggests a dispersal of bull groups at this time (C. Gates, pers. comm.). This pattern of bull group dispersal during the rut is similar to that observed in plains and hybrid bison (McHugh 1958; Fuller 1960). In summary, the herding behaviour of wood bison in the MBS (Larter and Gates 1987) showed seasonal trends similar to those of hybrid bison in WBNP (Fuller 1960) and in the SRL (Calef and Van Camp 1987).

3.6 Cultural Development and Land Use

3.6.1 History of the Area

The following section provides historical background on some of the communities in the WBNP area, including Fort Resolution, Fort Smith, Fort Chipewyan, Hay River, Garden River, Fox Lake, Jean D'Or Prairie and Fort Vermilion.

In 1786, the Northwest Company built a trading post called Slave Fort, east of the Slave River delta. The Hudson Bay Company constructed a post nearby at about the same time, and when the two companies merged in 1821, the trading centre was named **Fort Resolution**. Following establishment of an Oblate mission in 1852, it became one of the most important medical and educational centres in the region. In 1938, 39 Oblates, assisted by the Grey Nuns, built and administered a large hospital for the treatment of tuberculosis. In 1956, responsibility for the care of TB patients was transferred to the Charles Camsell hospital in Edmonton.

In June 1985, there were 471 people in Fort Resolution. The ethnic distribution was 58% Dene, 19% Metis and 23% other. English and Chipewyan are the predominant languages. Logging, hunting and trapping are the main industries, although mining offers some employment at Pine Point. Sawtimber production in 1983-84 was 4195 m³. The total income from fur sales in 1984 for 98 trappers in Fort Resolution and Pine Point was \$542,000. As in other communities in the area, the consumption of country foods is a significant contribution to personal income. Residents of Fort Resolution harvest at least 20 bison each year from the SRL. Excluding bison, the value of country foods harvested in 1982 was estimated at \$75,763 (Lutra Assoc. Ltd. et al. 1985).

Fort Smith, located midway between Lake Athabasca and Great Slave Lake on the Slave River, was established in 1874 by the Hudson Bay Company. The post was named in honour of Donald Alexander Smith, later Lord Strathcona, a Hudson Bay Company governor and a member of the first Northwest Territories Council. In 1876, the Roman Catholic mission located at Salt River was moved to Fort Smith. In 1915, the Northwest Mounted Police established a post at the head of the rapids upstream from Fort Smith, naming it Fort Fitzgerald. A representative of Indian Affairs and a regional medical superintendent arrived in 1911, and the Catholic mission began farming nearby to produce milk and meat.

After World War II, the population of Fort Smith quintupled as a result of the increase in government administrative facilities. In June 1985, there were 2468

residents. The ethnic distribution was 26% Metis, 18% Dene/Cree and 53% other. English, French, Chipewyan and Cree are the major languages. Today, Fort Smith is a government administrative centre for the Fort Smith Region and WBNP, and serves as the regional centre for forest fire control (DIAND). It is the site of the Thebacha Campus of Arctic College. Trapping and tourism are the main industries.

In 1984, the income from trapping recorded for 98 trappers in Fort Smith was \$445,000. Moose, bison and barren-ground caribou are the major big game species that contribute to the local economy. In 1983-84, the recorded harvest by native people was 88 moose, 120 bison, 828 barren-ground caribou. Non-native hunters took 31 moose and 17 barren-ground caribou. The bison harvest depends largely on the unpredictable movements of bison herds out of WBNP. Few bison are taken in years when the main herd remains in the park.

Fort Chipewyan was established on the shores of Lake Athabasca in 1788. Alexander Mackenzie was the chief representative of the Northwest Company in Athabasca, and he chose the settlement as the new regional headquarters for the Company. The post became the trading focus for the Athabasca district and principally for the Chipewyan Indians who had previously taken their furs to Hudson Bay Company posts on the coast. In 1796 or 1797, Fort Chipewyan was relocated to its present site on the north shore of Lake Athabasca near Mission Point, making it Alberta's oldest community. This move permitted the spring fur brigades to start earlier on their journey to Grand Portage.

At one time, Fort Chipewyan was the richest trading post in North America, and the fur trade remained economically important to the community well into the 1900s. More recently, commercial fishing has contributed significantly to the local economy, but this activity has declined since 1982 when tainted fish were found in Lake Athabasca.

The community's population is approximately 1300, most of native ancestry and belonging to either the Cree or Chipewyan bands or the Metis Association.

Today, firefighting either for the Province of Alberta or WBNP provides seasonal employment for many of the trappers. More permanent employment is found with government agencies, bands or the Metis Association. The Syncrude plant in Fort McMurray also provides permanent employment for a number of residents (SATA Systems Inc. 1983).

The tourism industry is just beginning to be actively pursued by some community groups including the Cree Band in close cooperation with the park.

The town of **Hay River** is located on the south shore of Great Slave Lake at the mouth of the Hay River. It is a major regional transportation and communications centre for the south Mackenzie region, and its development has been closely linked to the development of water, land and air transportation in the NWT.

The Northwest Company and the Hudson Bay Company operated trading posts in the area for periods of time from 1806-1878. Permanent settlement was well established by 1900, and churches, schools and hospitals followed, operated by the Catholic and Anglican churches. In 1939, a winter road was cut through from Hay River to Yellowknife, and in 1942, as part of the construction associated with the Alaska Highway, the US Army Corps of Engineers built an airstrip at Hay River, improved the road to Peace River, and built roads from Hay River to Fort Smith and Fort Simpson. Canadian Pacific Airways began weekly service between Peace River, Hay River and Yellowknife in 1945, and the all-weather Mackenzie Highway connected Hay River to the south in 1948. Commercial fishing began on Great Slave Lake in 1945, and by 1950, there were 10 companies and 611 licensed fishermen working out of the community. The economy of Hay River is still closely tied to fishing, transportation and communications.

The Hay River Indian Reserve occupies 1818 ha of land adjacent to the town on the east side of the Hay River. The area was originally municipal land, and the reserve was established in 1974 under Treaty 8 at the request of the local Hay River Dene.

Fox Lake is located in the Fox Lake Indian Reserve #162 (pop. 671 in 1985) on the south side of the Peace River about 80 km east of Fort Vermilion. The settlement was established by the Little Red River Band in 1899 under Treaty 8, and the reserve (10,440 ha) was created in the early 1900s. The settlement is served by a winter road to Jean D'Or Prairie, and only by air during the rest of the year. The economy is based on farming, hunting, trapping and seasonal firefighting.

Jean D'Or Prairie is located on the Jean D'Or Prairie Indian Reserve #215 (pop. 540 in 1979), about 60 km east of Fort Vermilion. The reserve was established by the Little Red River band in 1899 under Treaty 8 and expanded in 1900 and 1910. Hunting, trapping, farming and seasonal firefighting are the main sources of income.

Garden River is a small settlement located in WBNP on the Peace River at the mouth of Garden Creek. Before 1957, only four families lived there permanently with seasonal use by several others. After 1957, when compulsory education was enforced, about 20 families settled in Garden River. For several years, a sawmill operated in the community and provided employment, but it was moved to High Level in 1974. Today about 280 people live permanently in the community, depending on trapping, logging and seasonal firefighting for employment.

Fort Vermilion (pop. 775 in 1986) is located on the south tableland of the Peace River. A trading post was established near the mouth of the Boyer River by Charles Boyer in 1788, and several posts operated in the area until 1830. The settlement that grew up around the prosperous Hudson Bay Company post at the present site of Fort Vermilion has been occupied since 1830. Agriculture has been an important part of the economy since the early 1900s and was supported by the establishment of a Department of Agriculture experimental farm in 1903. In 1905, the northern boundary of the new province of Alberta was placed at the 60th parallel on the basis of the flourishing sawmill and flour mill located at Fort Vermilion. Many fine historical buildings from that period remain in the community. The present economy is based on agriculture and logging. This part of

northern Alberta is one of the fastest growing agricultural districts in the province.

3.6.2 Population Distribution

Settlement is sparse in the areas from High Level to Fort Chipewyan. Population estimates based on 1985 data are presented in Table 6.

Income in the area is derived from cereal crop and forage production, logging, the petroleum industry (exploration and development), trapping and some limited tourism. A fishing lodge is operated at Margaret Lake and casual fly-in fishing is popular at many other lakes in the summer.

Table 6: Population Distribution - High Level to Fort Chipewyan - 1985

Towns and Villages	Fort Vermilion	752
	Fort Chipewyan	1400
	High Level	2852
	La Crete	<u>601</u>
	TOTAL	5605
Indian Reserves	Little Red River (includes Fox Lake and Jean D'Or Prairie)	1220
	Tall Cree (includes Beaver Ranch)	271
	Boyer River (includes Child Lake)	209
	Bushe River (part of Dene Tha)	59
	Meander River (part of Dene Tha)	<u>320</u>
	TOTAL	2079
	About 30% of the rural population of ID 23 resides between High Level and WBNP. A very small number of ID 18 resides in the WBNP area.	1969
TOTAL RESIDENTS		<u>9653</u>

3.6.3 Hunting and Trapping in WBNP

Wildlife is one of the park's most significant resources. When WBNP was established in 1922, a census was taken of the people using the park area for hunting and trapping. Since that time, the descendants of those originally enumerated have been able to hunt and trap in the park, subject since 1949 to game regulations. Bison are protected from all hunting within WBNP boundaries.

By the mid-1970s, about 600 people held hereditary hunting and trapping rights, and in 1976, a permit system was introduced to prevent over-harvesting. Today, 370 permits are issued annually. About half of the permit holders both hunt and trap, while the rest are only hunters. Trappers took a total of \$605,000 in all forms of fur in 1980-81. This revenue is of particular significance to Fort Smith and Fort Chipewyan where most of the trappers rely on these earnings to supplement their income from other sources. In general, hunting is increasing and trapping activity is declining. In 1981-82, individual trapper income in Fort Chipewyan was between \$5000 and \$10,000 annually. The predominant species taken were beaver and muskrat (Parks Canada 1984).

The harvesting of animals can be valued both monetarily and culturally. The traditional cultural value of hunting and trapping is often more important to native people and is sometimes considered quite separately from the monetary value of the harvest.

3.6.4 Significance of Bison to Native People

The hunting of bison has a significant economic and cultural impact on communities that have access to the animals. In the recent past, over 100 bison have been taken legally by Fort Smith hunters; significant numbers are also taken by people from Garden River, Fort Resolution and Fort Chipewyan. Meat and hides cannot be sold but are often distributed in the traditional manner within communities, especially to the elders and disabled. This provides indirect economic support to members of the community, but more importantly, it fosters traditional community values and practices.

In 1970, an outfitter was licensed to guide non-resident hunters in the SRL and was issued a quota of 25 bison. This was increased later to 80 non-resident permits. Bison became an important economic resource and were highly sought after in the communities of Fort Smith and Fort Resolution (Van Camp 1987). However, the SRL bison population began to decline in the early 1970s. By the mid-1970s, local residents in the Fort Smith region were concerned that wolf predation was causing this decline and that their access rights to the bison would be lost if the decline continued. As a result of this pressure, the NWT government closed the recreational hunting season for bison in the SRL in 1977 and introduced a two-year wolf control program. Holders of a General Hunting License (GHL)* were then the only people permitted to hunt bison in the SRL, a situation that still exists. A GHL holder has the right to hunt or trap game for food or pelts on unoccupied Crown lands in the NWT as long as the species hunted has not been declared under the NWT Act to be in danger of extinction. The bison in the SRL and WBNP are classified as hybrids and are not listed as endangered species in the NWT Act, whereas wood bison in the MBS are on the list and are protected. The National Parks Act protects all bison within the park; however, once they cross the boundary into the NWT they are legal game for holders of a GHL. In Alberta, wood bison are defined as endangered wildlife in the wildlife regulations whereas plains bison are classified as domestic animals.

Many of the residents in local communities in and around WBNP and the SRL rely on traditional sources of income from hunting, trapping, and guiding. These people still depend upon maintenance of undeveloped wild lands and wildlife for survival. Many residents are conservationists who value and strive to maintain wilderness areas. A strong desire to harvest bison has developed over the years among many of those residents, especially those people who have hunted bison in the SRL for meat for generations. This desire stimulated the Fort Smith Hunters and Trappers Association, in 1982, to request the NWT government to commission

* In most cases, a GHL is issued to a member of a family or group that hunted lawfully in the NWT prior to 30 June 1953. The license holder may be a status or non-status Indian, Metis, Inuit, or non-native person (NWT Wildlife Service, pers. comm.).

a study into the feasibility of establishing a disease-free bison herd in the SRL (Boreal Ecology Services Ltd. 1982). The positive conclusions from that study led the association, in consultation with the NWT government, to commission a feasibility study in 1985 on the economic potential of extensive commercial ranching of bison in the SRL. With funding from the Economic Development Agreement Secretariat, a consultant was contracted and a three-phase report is nearing completion. Preliminary conclusions indicate that a commercial-scale bison ranch in the SRL would be economically and biologically feasible.

Concern about the continued decline of the SRL bison population stimulated a renewed effort to encourage public participation in bison management in the NWT. In 1986, representatives of the native organizations in Fort Smith and Fort Resolution established the Hook Lake Bison Management Committee which proposed regulation of the number of bison killed by GHL holders through public sanctions rather than by legislation. In addition, the committee recommended a reduction in wolves on the SRL to determine if survival of bison calves would improve. Increased production of bison for consumption is a priority with local native groups.

Harvesting of wildlife for food has been, and continues to be, a traditional pursuit of native residents of northern regions, even though large numbers of bison have not been available in the majority of these areas for many years. The current desires and demands of local residents reflect the need for more bison and enhanced animal productivity in the region for consumptive uses. Production of bison under natural free-ranging conditions would seem to be an acceptable alternative to conventional agricultural production of meat. Successful intensive management of bison as a wildlife resource could result in economic benefits for the region with increased revenues from hunters and an increased supply of game for northern residents (Hawley and Reynolds 1987). Development of such wildlife management strategies would appear to be in line with local desires and needs.

3.6.5 Forest Resource Use

Timber Berth 408 is the last of a number of berths that were once operated in the park as a result of the policies of former federal departments under which the park was administered. This timber berth will revert to the park in 2002 when the present 21-year lease to Canfor expires.

The leased property is 497 km² in area and contained an estimated 800 million board-feet of harvestable white spruce. The mill was originally in the community of Garden River in the park and most of its employees were park residents. The mill is now in High Level, and its economic benefits are lost to park residents though they still do most of the work associated with harvesting the trees.

In 1985-86, Canfor harvested 47.2 million board-feet with a product value of approximately \$8.5 million. In the period of 1977-86, production averaged 41.8 million board feet with a gross average value of \$4.3 million annually (Canfor, pers. comm.).

3.6.6 Tourism and Recreation in WBNP

Visitor use of WBNP is low due to its remote location, poorly developed road access system, small regional population and lack of high capability recreational resources. Fort Smith residents comprise the majority of park visitors, using summer recreational facilities, mostly at Pine Lake. Pine Lake is the only reasonably accessible, deep water lake near Fort Smith. Other lakes in the area are generally shallow with muddy bottoms and are not suitable for recreation.

A second visitor component are tourists from western Canada and the United States who visit the park as one stop in a larger trip. They generally use the campground at Pine Lake or other road facilities.

The third and least common type of visitor are highly motivated individuals and groups who come specifically to the park from a considerable distance. These users often travel into the back country or along the major rivers taking

advantage of the interpretive opportunities available in the population centres and in the park.

Projections for visitor use over the next five years are low. Recent visitor use statistics from Pine lake are presented in Table 7.

Table 7: Visitor Use Statistics - Pine Lake, WBNP

<u>Year</u>	<u>Number of Visitors at Pine Lake</u>
1984	2818
1985	2350
1986	2873

Source: Parks Canada 1984

Total park visitation is only about 200 visitors more than these figures. The use of the park by hunters and trappers is not included in this number. The park serves as a regional attraction for tourists and plays a role in the tourism marketing strategies of both the NWT and the Province of Alberta. Regional tourist associations and communities are promoting the region and encouraging visitation to provide economic benefits and a broader understanding of the region.

3.6.7 Bennett Dam

In the mid-1960s, the government of British Columbia constructed the Bennett Dam on the Peace River creating the Williston Reservoir. The filling of the reservoir between 1968 and 1971 created low water levels downstream that threatened to permanently disrupt the delicate ecological balance of the Peace-Athabasca delta. It is generally accepted that the dam has altered the flow regime of the Peace River, creating lower water levels in Lake Athabasca and the Peace-Athabasca delta.

The reduction in peak flows on the Peace River has largely eliminated the phenomenon of the 'hydrologic dam' created at the confluence of the Lake Athabasca and delta drainages and the Peace River. During high water on the Peace River, water would overflow the delta and block the normal lake and delta drainages, causing the delta to flood and recharging perched basins in the area. This peak river stage usually lasted only a few days, but it was normally sufficient to raise the delta and lake water levels significantly.

Before construction of the dam, ice jamming on sharp bends in the Slave River just downstream of Lake Athabasca occurred every 3 - 5 years, and sometimes more frequently as evidenced by the flooding of the Sweetgrass abattoir in 1958 and 1960 (Lothian 1976). This overbank flooding of the river due to ice jamming was a major source of recharge for the hundreds of perched basins between the river and Lakes Claire and Mamawe, but appears to have ceased as a result of river flow control. Most of the basins are now dry or nearly so, and this has caused a considerable loss of shoreline habitat essential for muskrats and waterfowl. Since the muskrat population has fallen so drastically, their harvest no longer plays a significant role in the economy of Fort Chipewyan.

Vegetation changes on the delta are an even more insidious effect of this drying trend, which has been enhanced if not caused by the damming of the Peace River. The delta meadows are of two types; grass meadows dominated by a coarse wet meadow grass (Calamagrostis canadensis) and sedge meadows dominated by Carex atherodes. The bison prefer to eat the sedge in the winter and both sedges and grasses in the summer. Both meadow communities require frequent flooding during part of the growing season to maintain meadow growth and prevent the emergence of a dominant willow community. These vegetation patterns are changing.

3.6.8 Mineral, Oil and Gas Exploration in Northern Alberta

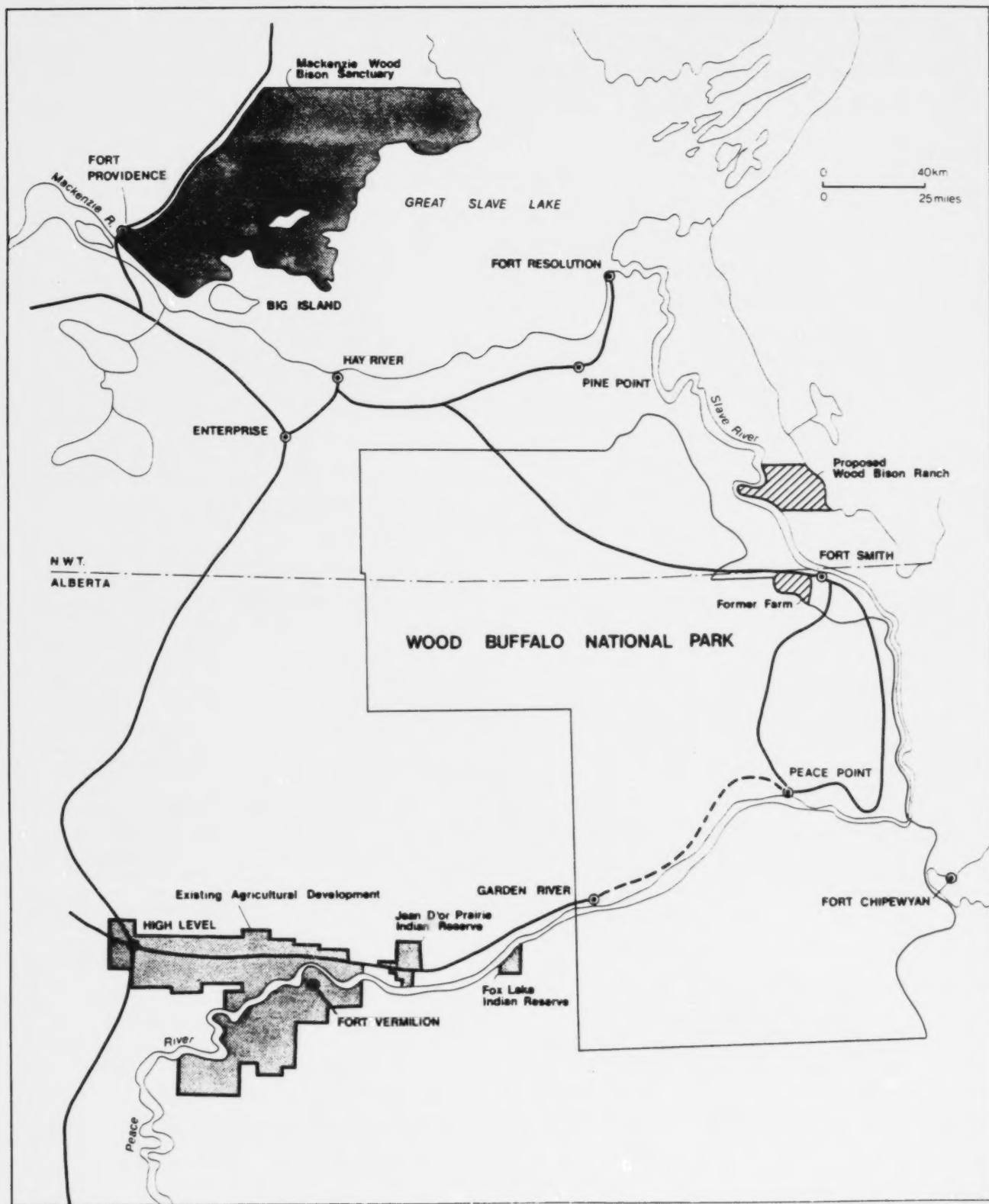
The mineral resources of the most northerly part of Alberta (north of township 101 and east of the 6th meridian) consist of natural gas, oil sands, gypsum and dimension stone.

Parts of the Boyer and Steen natural gas fields extend into the area of concern to the Task Force. The Boyer field produced about 300 million m³ of natural gas in 1985, and the combined gas reserves of the two fields are estimated at about 10 billion m³. There may be some potential for further natural gas and oil discoveries in the southern and western parts of the area. Three oil sands deposits occur along the southern margin of the area, but only two of these contain any reserves inside the area of concern, and these consist only of relatively small areas of low to moderate grade oil sands.

There are two gypsum deposits in the area - one at Peace Point in WBNP and the other just north of the park at Salt River (125-11W4). A granitic dimension stone deposit is located near Fort Chipewyan (113-7W4). The area around Lake Athabasca has good potential for uranium, but only limited exploration has been undertaken, and no deposits have yet been found. There is potential for other metallic minerals in the Canadian Shield area around Lake Athabasca, but this is considered low in view of the lack of mineral showings thus far discovered (D. Luff, Alberta Energy, pers. comm.).

3.6.9 Agricultural Use

Figure 6 illustrates land use patterns and the extent of agricultural development in the area of concern to the Task Force. Improvement District (ID) 23, commonly known as the Fort Vermilion district, lies immediately west of WBNP. This district contains Canada's most northerly farming area. Although farming began near Fort Vermilion in the late 1800's, the agricultural potential of the area was largely undeveloped until the establishment of railheads for grain at Keg River and High Level in the mid-1960s. This improvement, along with the construction of all-weather roads and bridges, provided the necessary infrastructure for rapid expansion of agricultural activity in the area. Construction of the veterinary clinic at Fort Vermilion was completed in 1977, and veterinary practice was started in the area in 1978. In the 1980s, agricultural growth slowed on the north side of the Peace River, but has continued steadily on the south side. However, the Jean D'Or Prairie integrated resource plan was completed recently



(after Tessaro in prep.)

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FIGURE 6. Regional development.

for an area of 26,000 ha east of Fort Vermilion and bordering the Jean D'Or Prairie Indian Reserve, and may result in the development of additional agricultural land.

In 1976, there were an estimated 10,000 head of cattle in the area, but by 1982, economics had forced this figure down to 2653. There are about 30 farmers between High Level, Keg River, and Fort Vermilion with 20 or more beef cows. The rest of the cattle are dispersed on about 100 farms with an average of 2-4 cows kept for both milk and meat. Cattle numbers have increased over the past two years and are expected to return to near previous levels. The Fort Vermilion grazing reserve opened in 1982, and in 1986, there were 1978 cattle on the reserve. The grazing reserve has capacity in excess of local needs, and 700 to 800 cattle are taken in annually from as far as Camrose and Provost for summer grazing and returned to central Alberta in the fall. The major markets for cattle from the area are Grande Prairie, Clyde and Edmonton. A small provincially inspected abattoir has opened recently at La Crete.

Other livestock in the Fort Vermilion district include 500-1000 horses, 2000-3000 pigs, 200 sheep, 300 goats, and 3000-4000 chickens.

3.6.10 Game Farming in the Area

Alberta

The new Wildlife Act in Alberta has brought about significant changes in the area of game farming. The legislation is now quite permissive, and a licence will be issued to a land owner when his facilities are completed in accordance with an approved development plan on his own deeded land. Elk are subject to the act and require permits and approvals from Fish and Wildlife Division. Plains bison are not included under the act and are managed as any other domestic stock.

One rancher raises about 250 head of bison under fence at Fort Vermilion. He has also developed facilities to raise elk, but that licence will not be issued until he has title to the land. Another rancher, also of Fort Vermilion, has had a plan

approved to keep up to 30 head of elk. His licence will not be issued until his facilities are completed and inspected. These sites are located approximately 106 km west of the park boundary and only 50 km west of the small free-roaming herd of bison between the Wabasca and Mikkwa rivers.

Government of the Northwest Territories

A study was commissioned by the Fort Smith Hunters and Trappers Association and the GNWT to determine the feasibility of establishing a bison ranch in the SRL. The study defined existing and potential markets, reviewed legal and regulatory constraints, examined production parameters, outlined base case financial feasibility, conducted social cost-benefit and risk analysis, and outlined a logistic plan and an implementation strategy. The conclusions of the study were:

- a commercial scale plains bison ranch is economically and biologically feasible;
- there are no substantive legal impediments to the development and operation of the ranch;
- a suitable site was identified east of the Slave River, although some hydrological modifications may be required to provide dry pasture during occasional wet periods; and
- a double perimeter fence would isolate the ranch bison from diseased free-ranging bison in the Slave River Lowlands.

The GNWT is currently reviewing this proposal with the Fort Smith Hunters and Trappers Association and may ask that wood bison be raised in order to maintain more long-term options.

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4.0 DISEASES

4.1 Anthrax

4.1.1 Brief Description

Anthrax is an infectious, febrile disease of warm-blooded animals caused by the bacterium Bacillus anthracis. The disease is characterized by its sudden onset, rapidly fatal course, exudation of tarry blood from the body orifices, absence of rigor mortis, and the presence of splenomegaly.

When material containing anthrax bacilli is exposed to air, spores are formed which protract the infectivity of the environment for very long periods; viability varies up to 60 years. The vegetative form of the bacillus is very susceptible to the action of disinfectants, sterilizing temperatures and desiccation, but the spore form is very resistant to environmental temperatures, sunlight, prolonged drying, and many disinfecting agents.

The incubation period may vary from a few hours to several days. The disease may manifest itself in a peracute, acute, or sub-acute form. The animal may die without premonitory signs, the course of the disease lasting an hour or two. Alternatively, the disease may last two to three days, and the animal may exhibit signs of depression, cease ruminating, stop feeding, become uncoordinated, have bloody discharges from the nostrils and anus, and edematous swellings involving various parts of the body. In the sub-acute form, the disease lasts several days, and some affected animals will recover.

In herbivores, anthrax is a result of soil-borne contamination. Soil and water contamination can occur as a result of anthrax-infected carcasses or by the effects of scavengers on these carcasses. When a disease outbreak is underway, blood sucking flies, such as horse flies and deer flies, can transmit anthrax by inoculation.

In Canada, outbreaks associated with soil-borne infection tend to occur when the ground temperatures reach 10 - 15°C and environmental conditions are warm and humid. An area that is contaminated with anthrax spores is a hazard to any herbivores that use it. If bison are replaced with cattle, the problem remains. Removal of animals from an infected area does not change the status of the area as anthrax is a soil-borne infection and an environmental contaminant.

Domestic animals, diagnosed in the early stages, may sometimes be treated successfully with antibiotics and anti-anthrax serum. Annual vaccination will provide protection.

4.1.2 History of Anthrax in WBNP Area

Anthrax was first diagnosed in the Slave River Lowlands (SRL) in 1962, and outbreaks were recorded in the SRL and WBNP area in the years 1962, 1963, 1964, 1967, 1968, 1971 and 1978 (Table 3). At least 1100 bison deaths were attributed to the disease, but the total number of deaths is unknown as undoubtedly many carcasses were never found (Tessaro, in prep.). In 1962, carcasses were buried, and in subsequent years they were burned and limed to reduce soil contamination.

Vaccination of bison for anthrax was carried out from 1965-1977 and then discontinued (see section 3.4).

4.1.3 Rationalization For the Status Quo

As this disease is soil-borne and spore survival is indefinite, anthrax will remain a potential problem for herbivores in the WBNP area and there is little that can be done. Anthrax is not carried or harboured by the bison themselves except during outbreaks of active infection. The contaminated environment serves as a potential source for the disease in the future.

The WBNP region seems to mark the northern limit for survival of the organism, and the environmental conditions required for development of the disease are usually absent. However, it is impossible to predict if and when an outbreak will

occur, or how many animals will be infected in the future. Although the seven outbreaks of the disease in the past 25 years have been dramatic, the total known losses have only been about 1100 animals (Tessaro, in prep.).

At present, astute management with surveillance when environmental conditions are conducive to anthrax outbreaks, burning and burial of carcasses during an outbreak to minimize contamination of soil, and vaccination of any captive populations are the only practical measures that should be continued. Anthrax would not appear to be a major factor in bison population dynamics at this time.

Canadian Parks Service (CPS) and Department of Renewable Resources, Government of the NWT (GNWT) have an emergency plan in place for handling outbreaks of anthrax. Included in that plan are techniques for disposal of infected bison carcasses and a public warning system to notify local people of the dangers of handling infected carcasses. The Task Force recommends that these contingency plans be examined and updated regularly, given the seriousness of the zoonosis. Health and Welfare Canada, GNWT, and CPS are pursuing this recommendation further.

4.2 The Entry of Tuberculosis and Brucellosis into Northern Bison Populations

Following uncontrolled slaughter of bison during the 19th century, the North American population in 1889 was estimated to be only 831 animals: 550 wood bison in Canada between the Slave and Athabasca rivers, and 281 plains bison in the United States, mainly in Yellowstone National Park. Protective legislation, establishment of government-owned herds and private bison ranches have saved the plains bison, and their North American population is now an estimated 90-95 thousand, though less than 100 of these are free-roaming on their former range. Canadian authorities have not yet addressed the status of plains bison (i.e. rare, threatened, endangered). However, fewer than 3000 wood bison exist today, virtually all of them in Canada, and they are nationally and internationally recognized as an endangered species. In April 1988, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) changed the status of wood bison

from endangered to threatened, reflecting the species steady recovery and growth. Wood bison continue to be listed as endangered under the NWT Act and by CITES (Convention on International Trade in Endangered Species).

Wood Buffalo Park was created in December 1922 to preserve the native habitat of the wood bison and to protect the species from extinction. At that time, there were an estimated 1500 wood bison in the 27,000 km² park area. The Peace River marked the southern boundary of the park.

Between 1907 and 1912, Canada purchased and received 716 plains bison from the Pablo-Allard herd in Montana. The first 410 of these animals were held at Elk Island National Park (EINP). Between 1909 and 1912, the remaining 306 Pablo-Allard bison were transported directly to Buffalo National Park near Wainwright, Alberta together with 325 of the Elk Island bison and 77 Banff National Park bison (Tessaro, in prep.). The bison that were left behind in EINP became the nucleus of the plains bison herd that is still there today.

The Wainwright plains bison multiplied under a regime of natural grazing and supplemental feeding until they exceeded the carrying capacity of the facility. Some were slaughtered for meat sales, and between 1925 and 1928, 6673 bison were sent by rail and barge to Wood Buffalo Park where they were set free. The decision to send plains bison to Wood Buffalo Park was hotly contested by members of the scientific community because the Wainwright plains bison were known to have bovine tuberculosis and because they would interbreed with the native wood bison resulting in a hybrid population (Tessaro, in prep.).

There is no history of disease in the WBNP area prior to shipment of plains bison to the park from Wainwright in the 1920s. It is believed these plains bison brought tuberculosis and brucellosis to WBNP. Bison in Buffalo National Park near Wainwright were pastured with cattle, and it is believed that this was the original source of tuberculosis and probably brucellosis in the bison herd. In 1923, 264 bison were slaughtered in Wainwright and 75% had tuberculous lesions. Testing for brucellosis in cattle was still in its infancy at that time, and the Wainwright bison were not tested prior to shipment to WBNP in the mid-1920s.

Abortions, orchitis, lameness and joint problems had been observed and suggest that the Wainwright bison had brucellosis (S. Tessaro, pers. comm.).

As mentioned above, bison in Buffalo National Park originated from EINP (formerly the Pablo herd in Montana), directly from the Pablo herd, and from the Banff herd. These herds in turn had their roots in bison calves caught by Alloway & McKay on the Canadian Prairies, and by Goodnight, Jones, Walking Coyote, and the Dupree brothers in the USA. Animals from some or all of these herds were brought together to form the Colonel Bedson, Lord Strathcona, Yellowstone National Park (which also had its own original animals), Blackstock Corbin and other herds (Ogilvie 1979). These original bison calves were often hand-raised or placed with a milk cow, and frequently, the bison herds were crossbred with cattle to develop a new hardy breed of cattalo. Any of these actions could have exposed the original bison to brucellosis and tuberculosis, which were widespread in cattle populations at that time.

It has been argued that brucellosis was endemic in bison herds prior to the introduction of cattle, but of course, this cannot be verified. If all modern bison herds were infected with brucellosis, this hypothesis might be more tenable. The species was saved from extinction by the capture of a very small number of animals, mostly calves, that were subsequently reared with cattle. These animals and their descendants were bought and sold back and forth to establish other independent herds throughout western North America. It is apparent that any contact with infected cattle would quickly have spread disease through many or all bison herds, and this is not the case.

The EINP herd was originally made up of 2/3 of the Pablo herd (which had originated with stock from the Walking Coyote, Col. Bedson, Buffalo Jones, McKay and Alloway herds), and the Banff herd (which originated from the Lord Strathcona, Col. Bedson, Blackstock and Goodnight herds). Some animals from the Banff herd were returned to Banff, and it is unclear what proportion of the original Elk Island herd was made up of animals from Banff. Blyth and Hudson (1987) report an extensive testing and slaughter program in EINP between 1929 and 1945 with negative results for both brucellosis and tuberculosis. Approxi-

mately 2000 animals were tested for brucellosis and 3000 inspected or tested for tuberculosis. Subsequent testing did reveal brucellosis, but this long span of negative tests combined with the park's proximity to farmland, use of park roads by farm vehicles, and use of farmers to haul hay and feed bison, suggest that Elk Island's disease problems originated with local cattle, populations. This also leads one to conclude that the temporary holding of animals at Elk Island between 1907 and 1909 on their way to Wainwright was not the cause of the infections later found at Wainwright.

It appears therefore that the Pablo herd was originally clean, but it does not rule out the possibility of infection of the Pablo herd between the first shipment to EINP in 1907 and the last shipment of bison from the Pablo herd directly to Wainwright in 1912. The Yellowstone National Park bison have brucellosis, and there have been suggestions it may have originated from the Pablo herd. The EINP history would lead one to question that theory.

Tuberculosis was not recorded in any bison herds prior to its identification in the Buffalo National Park herd in 1917.

In conclusion, it appears that tuberculosis has never been a problem with the Pablo bison herd or its successors, the Yellowstone National Park herd or the EINP herd. Tuberculosis in bison was first recorded at Buffalo National Park in Wainwright and subsequently in the WBNP hybrid herds.

Brucellosis was not easily identified at that time, but evidence from EINP suggests the original animals from the Pablo herd did not have brucellosis. Multiple biotype infection of the diseased hybrids suggests the possibility of more than one source of brucellosis (see section 4.4.4). Clinical signs suggestive of brucellosis were seen in the Wainwright bison, but brucellosis testing was not conducted.

The use of cattle farms as a source of feed, the supplemental feeding of bison, the use of cattlemen as ranch hands for park bison, and the pasturing of bison with cattle, all seemed reasonable and necessary for the management of bison at

the time, but also presented multiple sources and opportunities for disease transmission.

4.3 Tuberculosis

Tuberculosis is caused primarily by three species of bacteria of the genus *Mycobacterium*: M. tuberculosis, M. bovis, and M. avium. The agent was discovered by the German scientist Robert Koch in 1882.

Tuberculosis occurs in every country of the world and in all species including man. It is of major importance in cattle because of public health considerations and its detrimental effects on animal production.

Tuberculosis caused by M. tuberculosis or M. bovis is a "reportable disease" under the Animal Disease and Protection Act which requires owners, veterinarians, dealers, and caretakers of animals to report the appearance of the disease to the nearest Agriculture Canada veterinary inspector.

4.3.1 History of the Tuberculosis Control Program

The first testing of cattle for tuberculosis in Canada began in 1897 when testing was offered to livestock owners free of charge on request. There were no restrictions on the disposal of reactors, nor were they identified.

In 1907, a national meat inspection system was implemented. Through this system, reliable statistics became available on the incidence of tuberculosis in animals slaughtered under federal veterinary inspection. This, in turn, provided the impetus for the development of programs aimed at the control and eradication of the disease.

The voluntary Supervised Herd Plan was introduced in 1908. Reactors were identified and had to be removed from the herd, but they were not ordered slaughtered.

In 1914, the Municipal Tuberculosis Order was passed, under which municipalities could enact bylaws requiring that their civic milk supply come from a tuberculosis-free herd. Under this plan, the federal Department of Agriculture paid compensation for tuberculosis reactors.

In 1919, the Accredited Herd Plan was introduced. This is a voluntary program designed primarily for purebred herds, and for years, herds tested under this plan have provided a source of tuberculosis-negative purebred breeding animals, especially bulls. In 1960, there were more than 10,000 herds enrolled in the program, but by 1978 the number had decreased to fewer than 100 herds. Since 1963, owners have been required to employ an accredited veterinarian to conduct the annual herd tests and must now bear the costs of the testing individually.

It became apparent in the early 1920s that to control and eradicate tuberculosis it would be necessary to expand the testing program to include all herds in a geographical area and eventually all of the country. Under the Restricted Area Plan, mandatory testing on an area basis began in 1923, and by June 1961, the first general test of all areas in Canada was completed. Between 1923 and 1961, a total of 50 million tuberculin tests were performed, 400,000 reactors were ordered slaughtered, and approximately \$15 million in compensation was paid to livestock owners. Routine Area Testing continued from 1961 to 1976. When the program started in 1923, the national rate of infection was estimated at 4.5% of all cattle, and by 1985, it had been reduced to 0.015%.

Since 1976, all animals slaughtered in federally inspected plants are examined for tuberculosis, and all carcasses exhibiting suspicious lesions are traced back to the farm of origin. The herd at that farm is then tuberculin-tested and a final decision on the herd is based on the results of both the on-farm test and the lab culture of suspected lesions. When a suspected lesion is found to be culture positive, the herd of origin is depopulated (i.e. ordered slaughtered in a federally inspected plant), and compensation is paid to the owner. The farm corrals and barns are thoroughly cleaned and disinfected, and repopulation is permitted after approval of the cleaning and disinfection by the Veterinary Inspection Directorate. All sales and purchases from the farm for the previous 5 - 10 years are traced,

and all herds with possible contact are tested until the Department of Agriculture is certain the disease has been eliminated. This process of slaughter, screening and traceback will continue until the Department of Agriculture is certain the disease no longer exists in Canada.

In 1986, screening at slaughter discovered three herds in Alberta with what appeared to be long-standing tuberculosis infections, and these herds were slaughtered and contact herds were tested. That same year in New Brunswick, a herd of domestic bison were found to be infected and were slaughtered and tracebacks initiated. In January and February 1987, nine herds of cattle in Quebec were found to have tuberculosis, and depopulation and testing continues there.

It is hoped that by December 1989 the domestic livestock herd in Canada can be declared free of tuberculosis.

4.3.2 Cost of Agriculture Canada's Tuberculosis Eradication Program

The costs of the TB eradication program are difficult to determine because this program is integrated and administered concurrently with others. However, in 1978, the costs of manpower, operations, capital, grants and compensation for that year were estimated at \$3.35 million, of which \$218,000 was compensation for animals slaughtered. From 1922 to 1978, compensation costs alone were over \$16 million. It is estimated that compensation costs from 1978 to 1987 have amounted to another \$2 million (Morrisey 1983).

4.3.3 Importance of Tuberculosis Eradication Program to Agriculture in Canada

National Cattle Herd

From the start of the program to the present time, over 400,000 animals have been eliminated through herd depopulations.

In 1979, an Agriculture Canada study (Hendrick 1979a) of alternative tuberculosis programs concluded:

1. The farm-to-farm tuberculin testing of cattle would take 15 years to eradicate Mycobacterium bovis. It would result in an economic loss to the cattle industry of \$160,466 and a program cost of \$29 million.
2. With abattoir surveillance, traceback investigation and testing, and depopulation of tuberculosis-infected herds, it would take six years to eradicate M. bovis. The resulting economic loss would be \$64,200 with program costs of more than \$19 million.
3. If the tuberculosis program were discontinued in 1978, it was estimated through computer modelling that in 20 years 95% of the cattle herds and 30-35% of the Canadian cattle population would be infected with tuberculosis. Only 4.5% of Canadian cattle were infected when the tuberculosis eradication program started in 1923. The dramatic increase predicted in the infection rate was based on the fact that the cattle population as well as the average herd size has increased over the past few years. The estimated producer cost to Canada as a result of discontinuing the program would be more than \$644 million over that 20 years. This figure does not include export costs or human disease costs.

As a result of these studies, farm-to-farm testing was discontinued, abattoir surveillance and traceback intensified, and the effort to eradicate the disease became even more determined in the view of the staggering costs it could impose on the country.

Exports of Cattle, Semen, Embryos, Beef and Beef Products from Canada

Importing countries require a negative tuberculin test on the animals or donors of semen or embryos to be imported. The national Tuberculosis Eradication Program assists the exporter in meeting the requirements of the importing country and

facilitates sales through international recognition of the extremely low incidence of bovine tuberculosis in Canada.

Tuberculosis reactor cattle are ineligible for export after slaughter. These carcasses, minus condemnations, must be sold on the domestic market. Presently, this results in reduced value for a small number of carcasses, on average 600-800 per year (E. Broughton, Agr. Canada, pers. comm.). However, in the absence of a TB eradication program with a prediction of 30 - 35% prevalence of the disease, a large number of carcasses would be ineligible for export.

4.4 Brucellosis

Brucellosis is caused by bacteria of the *Brucella* species including *B. abortus*, *B. melitensis*, *B. suis*, *B. ovis* and *B. canis*. It was isolated by Danish scientist Bernard L.F. Bang in 1896 and is also known as Bang's disease, contagious abortion, Malta fever, and undulant fever.

Brucellosis in cattle is widespread and of major economic importance in most countries of the world. Human health concerns also arise as the organism can cause undulant fever in man. Brucellosis caused by *B. abortus* is a reportable disease under the Animal Disease and Protection Act.

4.4.1 History of the Brucellosis Program

Brucellosis has always been an economically serious disease of cattle. The government of Canada became involved in 1914 when attempts were made to inform the public about the disease through Agriculture bulletins. In 1923, an active research program was established to develop and improve serological and bacteriological methods. By 1929, research and experience in Canada led to a much greater understanding of the disease, and the Animal Contagious Disease Act was promulgated under which the Health of Animals Branch introduced a voluntary Bovine Infectious Abortion Herd Plan. The plan was established to assist breeders in controlling and eradicating the disease from their herds. This program continued until 1947 when the Brucellosis Free Listed Herd Regulation was

established. This was also voluntary, and the program demonstrated that, with care, a herd could be freed and maintained free of the disease. In 1950, a federal-provincial Calfhood Vaccination Program was established as a starting point for the eventual eradication program. As a control method, the vaccination program reduced the level of infection from 9% to 4.5% by 1957. At this time, the Brucellosis Test and Slaughter Program was established with the ultimate goal of eradicating the disease. Under this program, testing of all eligible animals was mandatory; infected herds were quarantined and reactors slaughtered with compensation from Agriculture Canada. The first general test of approximately 700 Brucellosis Control Areas was completed in 1966 during which 10,701,375 cattle were tested and 191,047 reactors were found and slaughtered.

The General Area tests continued until 1980 when the national infection rate was down to 0.02%, and farm-to-farm testing was gradually ended. The detection of the disease moved to the Milk Ring Testing program and the Market Cattle Testing program, which had been established in the early 1960s and which were more effective in uncovering infected herds than farm-to-farm testing.

By 1970, the Brucellosis Vaccination program was being de-emphasized because of the low level of infection and primarily because lingering vaccine titres were causing diagnostic problems. The vaccine also tended to mask infection in some herds thus perpetuating it. As expected, some residual infections were found, and it followed that there would be some spread to other herds because a growing number of cattle had become totally susceptible to the disease in the absence of vaccination. In fiscal year 1970-71, 3893 reactors were identified in 170 herds. The incidence of the disease climbed to a peak in 1976 and then declined to previous levels by 1980.

In the late 1970s, depopulation of infected herds was undertaken to eliminate any possibility of latent infection. Since 1977, all livestock for public sale must be Brucella-tested prior to sale, including those offered by dealers, farm auctions, auction marts, public stockyards and purebred sales.

As a result of this program, Canada was declared brucellosis-free in October 1985 in accordance with internationally accepted principles.

Since then, one infected cow (January 1986) and three infected herds with five culture positive animals (December 1986) have been found in Alberta; Manitoba had a single infected cow in February 1986. All reactors and contacts have been slaughtered and trace-backs are continuing.

It is recognized that isolated pockets of infection may still be found after a country has been declared brucellosis-free. Thus, extensive surveillance is being maintained and will be maintained for the next few years to ensure the elimination of the disease from Canada's domestic livestock herd.

4.4.2 The Cost of Canada's Brucellosis Program

The cost of brucellosis eradication has been calculated at about \$260 million. Of this, the compensation paid to owners from 1957-1982 was about \$46.5 million. An accurate cost for the vaccination program is difficult to determine because of the involvement of provincial governments in the administration of the program for many years. However, the cost of vaccine was \$71,375 in fiscal year 1984-85 and \$129,300 in 1985-86. The present time of the currently used, reduced dosage vaccine is \$1 per dose with delivery costs estimated at \$3 per animal (Keller, Agr. Canada, pers. comm.).

4.4.3 Importance of Brucellosis Eradication Program To Agriculture in Canada

National Cattle Herd

From the beginning of the test and slaughter program in 1956 to the present time, 378,000 cattle have been ordered destroyed due to brucellosis and approximately \$55.7 million has been paid in compensation by Agriculture Canada.

In a benefit-cost study completed by Agriculture Canada's Management Consulting Services in June 1979 (Hendrick 1979b), the simulation model of the "No Program"

alternative for both dairy and beef cattle predicted a dramatic increase in the numbers of infected herds and infected bovines. The cumulative discounted economic losses for both beef and dairy cattle would total \$494,223,416 over a 20-year period. In determination of economic losses, the following factors were considered: (i) culling loss, (ii) abortion loss, (iii) production loss, and (iv) dairy calf loss. The losses calculated in the simulation model did not include costs related to undulant fever and reduced export trade.

Exports of Cattle, Semen, Embryos, Beef and Beef Products

Canada's status regarding brucellosis is better than most other countries in the world. Therefore, for export to countries other than USA, an increase in the incidence of brucellosis in Canada would have little impact, provided it was possible to maintain brucellosis-accredited areas. If areas lost accredited status, restrictions on the export of cattle, semen and embryos in the world market would result, and Great Britain, Ireland, Sweden, Norway, and Denmark would place a ban on the importation of Canadian cattle.

If the incidence of brucellosis in Canada were to rise above that of the USA, Canada would probably lose up to 50% of its export feeder market which in 1983 was valued at about \$80 million. In addition, the USA would likely only permit the importation of cattle from Free Listed Herds, causing a further loss of exports and increased costs for exporters (McKeown, Agr. Canada, pers. comm.).

4.4.4 The Usefulness of Biotyping Technology in Epizootiological Studies of Brucellosis

A biotype is a group of strains within a bacterial species with a defined set of characteristics that allows it to be distinguished physically from other biotypes within that species. Biotyping is an internationally recognized method of identification and classification of a wide variety of bacteria, including the Brucellae, and is of considerable value in the epidemiological study of disease. In simple terms, it is a method of "finger printing" bacteria used to trace the origin and spread of infection. Application of this technology has also led to the discovery

of new biotypes and the recognition of distinct strains within biotypes which have further refined our understanding of various diseases.

There are nine biotypes of Brucella abortus, although a recent revision of the species removed biotype 8 from the list. On a world scale, B. abortus biotype 1 is the most common biotype found in cattle and is considered to be the "classical" or most typical example of the species. The relative incidence of the different biotypes varies between different countries. In the United States, 85% of cattle isolates are B. abortus biotype 1, with biotypes 2 and 4 making up the remainder. The few isolates examined from infected bison and elk in the USA were all B. abortus biotype 1. In Canada, virtually all isolates from livestock are either biotypes 1 or 4; biotype 1 is more common in eastern Canada and biotype 4 is more common in the west. A small number of atypical biotype 2 isolates were recovered from Ontario cattle, and typical strains of biotype 2 were found for the first time in Canadian livestock in the 1986-87 brucellosis outbreak near Vermilion, Alberta.

B. abortus biotypes 1 and 2 have been found in bison in WBNP and the SRL. These isolates were identical to field strains found in cattle, and no strains were discovered that could be considered unique to bison. However, a urease-negative strain (Strain 544) of biotype 1 was isolated from two bison, and this inability to split urea appears to be a stable characteristic of the strain and is a useful epidemiological marker. Strain 544 is a urease-negative field of B. abortus biotype 1 obtained from a cow slaughtered in the USA several decades ago. However, urease-negative strains of biotype 1 have only been found in Canada in the two WBNP bison and are rarely found in the USA and other countries. This increases the relative epidemiological significance of discovering this strain in bison. Should this strain be found in Canadian cattle, it would lead epidemiologists to investigate a connection with the diseased northern hybrid bison. The simultaneous presence of different biotypes and strains in the park bison suggests that either B. abortus has been changing within the bison population or, more likely, that the bison were historically exposed to more than one source of infection.

4.5 Prevalence of Tuberculosis and Brucellosis

4.5.1 Prevalence - Bison

In Canada, the only bison still known to be infected with tuberculosis or brucellosis are the hybrid bison of northern Alberta and NWT. This is a total of about 5500 animals with an infection rate estimated at 36% for both brucellosis and tuberculosis. The total Canadian bison population is under 15,000, and the North American bison population is 90,000-95,000 animals.

4.5.2 Prevalence - Cattle

M. bovis in cattle has not been found in Newfoundland, P.E.I., Nova Scotia, Manitoba, Saskatchewan, or British Columbia for at least five years, and thus these areas are classed as tuberculosis-free. Alberta is also classed as tuberculosis-free as it has had only one source herd in at least five years. The other provinces, New Brunswick, Quebec and Ontario, have an incidence rate of less than 0.2% and are tuberculosis accredited. Eradication of M. bovis from the Canadian cattle herd is projected for December 1989.

Canada has been considered brucellosis-free since 1985. Since that time we have had five infected herds with a total of 23 serologically positive animals.

The total Canadian cattle population is estimated at 11,465,000 animals.

4.5.3 Prevalence - Humans

According to Grzybowski et al. (1972), the rate of tuberculosis among Indians was consistently 10 times higher than in the rest of the Canadian population. Since 1972, considerable effort has been made to improve the health status of native people and reduce the incidence of tuberculosis. However, unfavourable reports from native communities in 1973 and 1974 emphasized the need for attention to this problem. In 1974, for example, 291 active tuberculosis cases were diagnosed in Manitoba (Hershfield 1974), 260 were new patients and 31 were reactivations.

While an insignificant increase in new cases was reported among the white population (3.7%) in 1974 compared to 1973, the increase in treaty Indians was 67.9%. Moreover 72.2% of reactivation cases were also Indians.

In Saskatchewan, the rate of active tuberculosis in the non-Indian population was 11 per 100,000 and 12.3 times higher in registered Indians. In B.C., tuberculosis cases among registered Indians increased from 45 in 1973 to 79 in 1974. At the same time, the number of tuberculosis patients of Canadian origin declined from 327 in 1973 to 274 in 1974.

More recent figures indicate this trend is continuing. The following table outlines the number of reported active TB cases in Alberta over the last three years.

Table 8: TB Incidence in Alberta (1984-1986)

<u>Year</u>	<u>Registered</u>	<u>Metis</u>	<u>Other Canadian Born</u>
84	45	20	65
85	34	15	55
86	51	11	55

The figures in this table clearly indicate that the incidence of active tuberculosis in Alberta is far higher in the Indian population than in the mainstream population.

Incidence of Bovine Tuberculosis In Humans

All confirmed cases of tuberculosis are typed, and over the last several years, no cases of bovine tuberculosis have been reported in humans in Alberta or the NWT.

Incidence of Brucellosis in Humans in Alberta & NWT (Southern Mackenzie)

Dr. D. Kinloch, Program Medical officer, NWT Region, Health and Welfare Canada, indicated that to his knowledge there have been no cases of human brucellosis reported in the last three years in the NWT south of Yellowknife.

In Alberta, one case of brucellosis was identified in 1985 in a person from Good Fish Lake, but the source of the infection was not identified. No other cases of brucellosis have been identified in the last five years.

4.5.4 Prevalence - Other Species

At the closing of Buffalo National Park near Wainwright in 1939, bison, elk, moose and mule deer were all infected with tuberculosis. Between 1946 and 1969, brucellosis was also found in elk and bison in EINP (Tessaro 1986). Since then, other species infections have been rare and secondary to infection of cattle or bison.

4.6 Tuberculosis - Detailed Discussion

Tuberculosis is a chronic infectious disease caused by bacteria of the genus Mycobacterium. The main species are:

Mycobacterium tuberculosis - Human

Mycobacterium bovis - Bovines

Mycobacterium avium - Avian.

Under natural conditions, the bovine type of the bacillus causes disease chiefly in cattle, man, swine, and occasionally in horses, dogs, cats and sheep; the avian type causes disease chiefly in birds and occasionally is found in cattle, swine, horses, and sheep; the human type bacillus is chiefly responsible for tuberculosis in man and occasionally infects pigs, captive monkeys, dogs, and cattle. Although the human, bovine and avian bacilli may produce disease in a wide range of species under conditions of special exposure, it is interesting to note that they

are each naturally maintained in only one species, the human bacillus in man, the bovine in cattle, the avian in fowl. Thus, in the absence of infection from cattle, the bovine type disappears from the human population, and control of tuberculosis in cattle or poultry virtually eliminates these infections from pigs (Jubb et al. 1985).

4.6.1 Clinical Signs of Tuberculosis

Cattle

Although signs referable to localization in a particular organ usually attract attention to the possible occurrence of tuberculosis, some general signs are also evident. Progressive emaciation unassociated with other signs should always arouse suspicion of tuberculosis. A capricious appetite and fluctuating temperature are also commonly associated with the disease. Affected animals tend to become more docile and sluggish, but the eyes remain bright and alert. These signs often become more pronounced after calving.

Pulmonary involvement is characterized by a chronic cough due to broncho-pneumonia. In the advanced stages, when much lung tissue has been destroyed, there is laboured breathing with an increased rate and depth of respiration, and tuberculosis pleurisy may occur. Involvement of the bronchial lymph nodes may cause respiratory difficulty because of constriction of air passages.

The most common signs of alimentary involvement are caused by pressure of enlarged lymph nodes on surrounding organs. Retropharyngeal lymph node enlargement causes difficulty in swallowing and noisy breathing due to pharyngeal obstruction (Blood et al. 1983). Involvement of the digestive tract is indicated by intermittent diarrhea and constipation in some instances (Amstutz 1980).

Uterine tuberculosis (metritis) is uncommon with bovine strains except in advanced cases. It may occur as a result of coitus or by contiguity from tuberculous peritonitis, but in most cases results from generalized hematogenous spread. Bursitis and inflammation of the fallopian tubes are common. Similarly, tuber-

culous peritonitis may occur by upward spread from the uterus to the peritoneum. In metritis, there may be interference with conception, or conception may be followed by recurrent abortion late in pregnancy, or a live calf may be produced which in most cases dies quickly of generalized tuberculosis. In cows that fail to conceive, there may be a chronic purulent discharge, heavily infected with the organism (Blood et al. 1983).

Lesions of the central nervous system may cause paresis, hyperesthesia, circling or other motor dysfunction (Amstutz 1980).

Bison

Clinical signs of tuberculosis are rarely seen in wild bison. Usually, the animal is eliminated by predators before the disease has progressed to that stage. Further, clinical examination of wild bison is very difficult. It is assumed that the signs are similar to those in cattle.

Occasionally, an animal with signs of depression, debility, and immobility has been observed by WBNP wardens. In 1974 on the road between Pine Lake and Peace Point, an animal was seen on several occasions over the period of a week in exactly the same location by the road. It appeared thin and depressed and did not run off when passed by a vehicle. When the Canadian Wildlife Service veterinarian arrived on the scene, the animal was dead. Postmortem revealed a massive generalized tuberculosis infection.

Tessaro (in prep.) provides the following descriptions of wolf kills:

"Three of four wolf-killed bison that I collected had severe TB lesions, and wardens and I observed the deaths of these animals. A calf with tuberculous encephalitis was severely ataxic and stood in saw-horse position with head lowered. It made no attempt to flee when the wolves attacked it. A mature cow with extensive pulmonary TB could not keep up with the herd when chased by wolves. She lagged 100 meters behind and was finally driven into deep snow by the attacking wolves and was then killed. An old bull was seen lying down (sternal) on the ice at Prairie River and appeared to be indifferent to the wolves circling it. When I returned later that day,

the bull was dead but only had a few bite wounds to the hind legs. P.M. [post mortem examination] revealed extensive pulmonary, pleural, hepatic, and renal TB with tuberculous orchitis and generalized lymphadenitis. The bull had severe congestive heart failure lesions (hydropericardium, ventricular dilation, nutmeg liver, congestion of the little remaining pulmonary parenchyma)."

Humans

Tuberculosis is important as a cause of human disability and death in many parts of the world. The infection may cause clinical disease rather shortly after inoculation (i.e. four to eight weeks, referred to as primary tuberculosis) or after a period of months or decades of dormancy (referred to as post-primary pulmonary tuberculosis or adult tuberculosis). Post-primary pulmonary tuberculosis is by far the most important form and accounts for the majority of active cases reported. In Canada, 70% of all active cases are post-primary pulmonary tuberculosis (Grzybowski 1983). It is also the only form of the disease that is infectious, thereby providing the means by which tuberculosis can be perpetuated in the community.

Primary infection usually goes unnoticed clinically; tuberculin sensitivity appears within a few weeks, and lesions commonly become inactive, leaving no residual changes except pulmonary or tracheobronchial lymph node calcification. The disease may progress to active pulmonary tuberculosis, pleurisy, or lymphohematogenous dissemination of bacilli to produce miliary, meningeal, or other extra pulmonary involvement. Cough, fatigue, fever, weight loss, hoarseness, chest pain, and hemoptysis may occur, but often are absent until advanced stages.

Extra-pulmonary tuberculosis is much less common than pulmonary tuberculosis. It includes tuberculous meningitis, acute hematogenous tuberculosis, and involvement of bones and joints, eyes, lymph nodes, kidneys, intestines, larynx, skin or peritoneum (Benenson 1975).

Other Species

Swine - Tuberculosis lesions in cervical lymph nodes usually cause no clinical abnormality unless they rupture to the exterior. Generalized cases present a syndrome similar to that seen in cattle although tuberculosis involvement of the meninges and joints is rather more common.

Horses - The most common syndrome in horses is caused by involvement of the cervical vertebrae in which a painful osteomyelitis causes stiffness of the neck and the inability to lower the head and feed at ground level (Blood et al. 1983). There is also loss of condition despite a normal appetite and abundance of food (Catcott and Smithcors 1972).

Sheep & Goats - Bronchopneumonia is the most common form of the disease in these species and is manifest by cough and terminal respiratory embarrassment (Blood et al. 1983).

Other Wildlife - The detection of tuberculosis in wildlife is hampered by the lack of proven test methods. There is no reliable blood test, intradermal tuberculin tests have not been properly evaluated in many wildlife species, and lymphocyte activation tests are not yet perfected.

Mycobacterial infections due to M. bovis were found in approximately 6% of elk, 6% of moose, and 1% of mule deer that ranged with infected bison at Buffalo National Park near Wainwright (Tessaro 1986). The disease has also been found in white-tailed deer, elk, bison, wolves, farmed mink and foxes, various zoo animals in North America, European badgers, brush-tailed opossums in New Zealand, feral pigs in Australia, Asian buffalo, and Cape Buffalo.

4.6.2 Transmission of Tuberculosis

Cattle

The infected animal is the main source of the infection, although mediate infection can occur. Organisms are excreted in the exhaled air, in sputum, feces (from both intestinal lesions and swallowed sputum from pulmonary lesions), milk, urine, vaginal and uterine discharges, and discharges from open peripheral lymph nodes. Entry is commonly by inhalation or ingestion. Inhalation is almost invariably the portal of entry in housed cattle, and even in those at pasture, it is considered to be the principal mode of transmission. Infection by ingestion is obviously more likely at pasture when feces six to eight contaminate the feed, communal drinking water, and feed troughs. Under natural conditions, stagnant drinking water may cause infection for up to 18 days after last use by a tuberculous animal, whereas a running stream does not represent an important source of infection to cattle in downstream fields.

The persistence of infectivity on pasture and other inanimate objects is difficult to determine precisely because of the varying conditions under which experiments have been carried out. Viable M. tuberculosis bacilli can be isolated from the feces of infected cattle and from ground in contact with the feces for six to eight weeks after the feces are dropped, but will be the duration of infectivity of the pasture to susceptible cattle varies widely. The period may be as short as one week if the weather is dry and pastures are harrowed but will be much longer in wet weather.

The drinking of infected milk by young animals is one of the most common methods by which tuberculous is spread. Less common routes of infection include intrauterine infection at coitus, the use of infected semen or insemination or uterine pipettes, and intramammary infection caused by contaminated teat siphons or cups of milking machines.

The degree of infection is usually much lower in beef cattle because of the open range conditions under which they are kept. However, herds may suffer a high

morbidity if infected animals are introduced and large numbers of animals have to drink from stagnant water holes, especially during dry season (Blood et al. 1983).

In congenital tuberculosis, the infection spreads via the umbilical vessels to the fetus. This route is not significant in other species because tuberculous endometritis is common only in cows (Jubb et al. 1985).

Bison

It is believed that transmission of tuberculosis in bison is similar to that in cattle. Bison are gregarious animals and aerosol transmission likely occurs, but not to the extent that it would in housed cattle.

Post mortem records for bison show a predominance of tuberculous lesions in the head and thoracic lymph nodes which suggests infection is most common via the respiratory tract (as is the case with cattle). Choquette et al. (1961) and Tessaro (1986) suggest that alimentary infection is not nearly as common as respiratory infection.

Congenital infection and infection of bison calves by ingestion of the dam's infected milk is also probable; however, in a wild herd these calves are not observed.

Humans

People with active pulmonary tuberculosis are the principal source of infection in other humans. The organisms are contained in respiratory secretions that are coughed up and expectorated or expelled in sneezing, talking or during other respiratory efforts. The organisms thus liberated into the environment may be reduced to droplet nuclei that remain suspended until inhaled. They may also be inhaled in the form of droplets or adhere to dust particles that are inhaled when stirred up. Particles greater than 10 μm are usually caught on the mucociliary blanket and cleared from the lung without harm, but droplets of smaller size have

the best chance of retention in the pulmonary alveoli where they are most likely to cause infection.

There is disagreement in the medical and public health literature as to whether tuberculosis can be spread on hands, dishes, glasses, utensils, or fomites. It is recommended that one err on the side of safety and assume that TB may be spread by these means.

In the Western world where bovine tuberculosis has been controlled, the route of entry in humans is almost exclusively via the lung. In areas where bovine tuberculosis is endemic, tuberculosis may be transmitted through ingestion of raw unpasteurized milk or dairy products and sometimes by airborne spread to farmers and animal handlers.

Susceptibility to tuberculosis is general. It is highest in children under three years, lowest in later childhood; susceptibility is high again in adolescents and young adults, undernourished, neglected and fatigued persons or those with silicosis, diabetes, myxedema, leukemia, Hodgkins disease, partial gastrectomies, or those on corticosteroid or immunosuppressive therapy. Alcoholics may be especially susceptible (Benenson 1975).

A number of factors are known to influence the risk of infection. As a general rule, infection occurs only after long and close exposure to an infected case. The increased risk of infection with low socioeconomic level appears to arise through overcrowding and general lifestyle.

Other Species

Swine - Tuberculosis in swine usually arises through infection from the local cattle population and is caused either by ingestion of infected dairy products or by grazing over the same pasture as infected cattle. The feeding of tuberculous cattle carcasses to pigs has also caused severe outbreaks of the disease. The incidence of the disease in swine is usually lower than in the cattle population from which the disease derives due in part of their early age of slaughter and the

tendency of tuberculosis to remain localized in pigs. The incidence is higher in older pigs.

Sheep - Sheep have always been considered resistant to tuberculosis, but recent experience in New Zealand has shown that the disease can infect up to 5% of some flocks, under the particular circumstances of high prevalence in local cattle and opossums (Blood et al. 1983).

All species and age groups are susceptible to M. bovis. Cattle, pigs and particularly goats are most susceptible. Sheep and horses show a high natural resistance, although all three types of Mycobacteria can produce localized or generalized disease in horses. The route of infection in horses is almost exclusively alimentary (Jubb et al. 1985). Tuberculosis may also be encountered in bison, deer, camels, birds (M. avium) and other wild fauna, and these animals may act as a source of infection for cattle.

4.6.3 Pathogenesis of Tuberculosis in Animals

Tuberculosis spreads in the body in two stages, the primary complex and post-primary dissemination. The primary complex consists of the lesion at the point of entry and in the local lymph node. This is common when infection is by inhalation. When infection occurs via the alimentary tract, a lesion at the site of entry is unusual, though tonsillar and intestinal ulcers may occur. More commonly, the only observable lesion is in the pharyngeal or mesenteric lymph nodes. A visible primary focus develops within eight days of entry by the bacteria. Calcification of the lesions commences about two weeks later. The developing necrotic focus is soon surrounded by granulation tissue and lymphocytes, and the pathognomic 'tubercle' is established. Bacteria are transmitted from this primary focus, which is in the respiratory tract in 90-95% of cases in cattle, to a regional lymph node and cause the development of a similar lesion there.

Post-primary dissemination varies considerably in rate and route. It may take the form of acute miliary tuberculosis, discrete nodular lesions in various organs, or chronic organ tuberculosis caused by endogenous or exogenous reinfection of

tissues rendered allergic to tubercloprotein. In the latter case, there may be no involvement of the local lymph node. Clinical signs vary depending on the sites of localization of infection, but because the disease is always progressive, there is a constant underlying toxemia which causes weakness, debility and the eventual death of the animal.

The disease is progressive in cattle, horses, sheep, and goats. Although generalized tuberculosis occurs in pigs, localization is more commonly found as nonprogressive granulomas in the lymph nodes of the head and neck (Blood et al. 1983).

Gross Pathology - Tuberculosis in Cattle

Cattle, sheep and goats show identical lesions. Tuberculosis granulomas may be found in any lymph nodes, but particularly in retropharyngeal, bronchial, and mediastinal nodes, and many organs. In the lung, miliary abscesses may extend to cause a suppurative bronchopneumonia. The pus has a characteristic cream to orange colour and varies in consistency from thick cream to thick, crumbly cheese. Small nodules may appear on the pleura and peritoneum.

All localized lesions of tuberculosis tend to stimulate an enveloping fibrous capsule, but the degree of encapsulation varies with the rate of development of the lesion (Blood et al. 1983). When the disease becomes progressive, the tubercles enlarge, frequently rupture, and infect contiguous tissues. After invasion of blood or lymph vessels, the organism may spread to all parts of the body (Amstutz 1980).

In congenital infection of calves, the primary complex is found in the liver and portal nodes. Congenital tuberculosis in calves progresses quite rapidly, and the animals usually die in a few weeks or months. By then, the disease has generalized and lesions can be found especially in the lungs, regional lymph nodes and the spleen.

Pulmonary lesions progress from terminal bronchiolitis, through unencapsulated small lesions of yellowish caseation and calcification, caseous lesions encapsulated

and heavily calcified, caseous acinar bronchopneumonia, caseous lobular bronchopneumonia to chronic caseous pneumonia. Ulcers in the trachea and bronchi are commonly associated with progressive pulmonary tuberculosis.

Nodular, heavily encapsulated lesions containing bright yellow caseous material can be found in the liver, kidneys, and in the skeleton. On serous membranes (pleura), they may be nodular in clusters, a condition called "pearl disease". Caseating tuberculous pleuritis consists of large plaques of caseous material under the pleura. In tubercular meningitis, lesions tend to be more exudative and necrotizing. Tubercles and ulcers may be found in the small intestine and caecum in adults, in which they frequently represent reinfection from the lungs (Jubb et al. 1985).

Gross Pathology - Tuberculosis in Bison

The pathology of tuberculosis in bison is similar to that in cattle.

It is not uncommon to find the carcasses of bison that have died of generalized TB, despite the predisposition of these animals to predation. Tuberculous lesions seen in these bison are similar to those in cattle. These lesions include: pulmonary TB, tuberculous lymphadenitis (individual nodes or generalized), generalized TB, hepatic TB, renal TB, splenic TB, and TB encephalitis, metritis, and orchitis.

Pathology and Pathogenesis of Tuberculosis in Humans

In non-immune people, tubercle bacilli can enter the body by several routes: lung, gastrointestinal tract and direct cutaneous and percutaneous inoculation. The most important, however, is the lung. The majority of lesions in the early phase of infection are in the lower two-thirds of the lung where ventilation is best and disposition of the droplet nuclei more likely. After phagocytosis in the non-immune host, the bacilli may remain viable or multiply occasionally within macrophages for an extended period. The organisms reach regional (hilar) nodes and even the bloodstream before their progress is inhibited by the gradual

development of specific immunity over a period of several weeks. At this time, the characteristic tissue reaction develops with epithelioid cell granulomas and caseation necrosis in the pulmonary lesion, regional lymph nodes, and at any site to which the bacilli have spread. The number of bacilli drops drastically with the appearance of the caseation necrosis, indicating that caseation is associated with the release of lymphokines from T-lymphocytes and enzymes from macrophages which destroy host tissue as well as tubercle bacilli. The infection in the primary site usually heals by a combination of resolution fibrosis and calcification.

Early in the course of a new infection, tubercle bacilli reach the blood circulation system in varying numbers. This event is marked by fever and mild symptoms and is recognized as tuberculosis only when a patient is observed closely because of recent exposure to the disease. This stage is important in the pathogenesis of tuberculosis because it is the time when bacilli reach distant sites to establish metastatic foci of infection from which clinical tuberculosis may develop much later.

During this dissemination process, bacilli presumably reach all organs, but they establish lesions with frequency in only a limited number of sites which have one feature in common: high tissue oxygen tension. The apices of the lungs for example, have the highest oxygen tension in the body (130 mm Hg) when in the upright position. This is due to the high ventilation-perfusion ratio, and it is probably due to this high oxygen tension that these sites are most frequently where viable bacilli persist in a dormant state in metastatic foci.

When a tuberculosis lesion regresses and heals, the infection enters a latent phase in which it may persist without producing illness. Though the infection may remain dormant for life, it may develop into clinical tuberculosis at any time if the persisting intracellular organisms begin to multiply rapidly.

Fibrocaceous tuberculosis may develop from either direct progression of the initial infection or reactivation of a dormant lesion, most commonly in the apical portion of the lungs. An old caseous hilar lymph node occasionally liquefies and spills its

contents into a bronchus to produce a segmental or lobar tuberculosis pneumonia. Massive blood stream invasion (miliary tuberculosis) may also occur at any time.

Gross Pathology - Tuberculosis in Other Species

Horses - Primarily, tuberculosis manifests itself as large lesions in the retro-pharyngeal or mesenteric nodes; sometimes ulcers occur in the intestine, but fatal cases result from generalization with either miliary tubercles or coarse nodular lesions. Secondary lesions have been described in the lungs, liver, spleen, serous membranes, mammary glands, skin, and in cervical vertebrae. Whereas extensive caseation and calcification are typical of bovine tubercles, equine tubercles have a uniform grey, lardaceous appearance and resemble a sarcoma.

Sheep and Goats - The pathology of TB in sheep and goats is similar in most respects to the disease in cattle.

Swine - Tuberculosis is seldom observed in pigs except at meat inspections, and because these animals are usually young, a local lymphadenitis is typically the extent of the disease.

Dogs and Cats - Cats are highly resistant to the human type bacillus, but highly susceptible to the bovine type. Dogs are susceptible to both types. The route of infection in cats is almost always alimentary, and in dogs it may be either respiratory or alimentary. The lesions of tuberculosis in carnivores differ from those in other species. Typical tubercles and tuberculous granulomatous tissue do not occur; the lesions are composed instead of a non-specific granulation tissue. Caseation does not occur, but liquefaction with the formation of a milky pus often does.

4.6.4 Prognosis - Tuberculosis in Animals

Prognosis for the individual animal infected by tuberculosis is extremely variable. Progress of the disease is dependent upon factors such as the state of nutrition and susceptibility of the host as well as the virulence and number of invading organisms. Body defences may arrest the disease by effectively encircling the invading organisms in a tough fibrous capsule, thus forming the tubercle (Amstutz 1980).

The prognosis for a calf infected in utero or at a very early age from an infected dam's milk is probably very poor. The prognosis for a healthy young yearling infected by a few organisms ingested from an infected pond may be very good. However, pathologists suggest that the disease in cattle is continuously progressive, although the rate of progress varies.

The prognosis for an infected bovine herd is poor. The organism will not spontaneously disappear and problems with treatment invariably lead to a test and slaughter program to clean up the disease.

4.6.5 Control Strategies - Tuberculosis in Animals

Many countries have achieved virtual eradication of bovine tuberculosis, including Norway, Denmark, Sweden, Switzerland, Iceland, and the Isle of Man. The methods used have depended on a number of factors, but ultimately the test and slaughter policy has been the only truly effective one.

Control in a herd depends on removal of the infected animals, prevention of the spread of infection, and avoidance of further introduction of the disease. All three elements are of equal value, and neglect of one may result in failure of the eradication program.

Detection of infected animals depends largely upon the use of the tuberculin test. The single intradermal test is widely used, but other tests are available and should be used when indicated.

4.6.6 Treatment of Tuberculosis in Animals

The treatment of animals with tuberculosis has been re-examined in light of progress in the treatment of human tuberculosis with such drugs as isoniazid, rifampin, and combinations of streptomycin and para-aminosalicylic acid and other acids. Claims have been made for the efficiency of long-term oral medication with Isoniazid both as a treatment and as a prophylaxis, although treatment is deemed impractical (Blood et al. 1983).

Treatment with isonicotinic acid hydraxine (INH) is inexpensive and easy. The disadvantages include a high percentage of refractory cases (25%), emergence of drug resistant strains, elimination of INH in the milk, and danger of relapse when the drug is withdrawn (Amstutz 1980). These disadvantages are so significant that the treatment of bovine tuberculosis is not allowed in the United States and in Canada is allowed only with the permission of Agriculture Canada.

Prevention Since 1890, various types of vaccines, including Bacille Calmette-Guerin (BCG), have been advocated for cattle, but none has produced effective immunity to bovine tuberculosis. Besides affording no practical protection to cattle, vaccination induces hypersensitivity to tuberculin and thus interferes with the diagnostic test. Countries that have attempted to use vaccination as the basis of a control program have ultimately abandoned the procedure in favour of the test and slaughter method (Amstutz 1980).

4.6.7 Treatment and Prevention of Tuberculosis in Humans

Treatment

Tuberculosis is curable with appropriate drug therapy. Active disease is treated with a combination of two or more anti-tuberculosis drugs given daily or bi-weekly for a period of 6-18 months. Chemoprophylaxis is given to recent contacts of active cases and to those whose Mantoux tests have converted to positive without signs of active disease. This involves nine months treatment

with one or two drugs in a daily or bi-weekly routine. Appropriate follow-up is arranged through local health units.

Prevention

The BCG vaccine is a live attenuated strain of bovine tubercle bacilli which has been used in many countries to induce specific immunity against tuberculosis. In Canada or the USA, BCG is generally used as protection for high risk groups. All native children in Canada (except those in Quebec and Newfoundland) are offered BCG vaccine.

The protection conferred by use of the vaccine has varied markedly in different field trials, perhaps related to some special characteristics of the population or to the quality of the vaccine. In Great Britain and Europe, field trials indicated that it afforded 80% protection against the development of clinical tuberculosis. In the USA and India, similar field tests showed much lower levels of protection. In Alberta, BCG vaccination has been proven to provide about 50% protection.

Other preventative health measures include:

- (a) improve social conditions, such as overcrowding, that increase the risk of infection;
- (b) educate people at risk in the ways tuberculosis is spread and methods of control;
- (c) provide public health nursing and outreach services for home supervision of patients to ensure compliance with the therapeutic regimen and to arrange for examination and preventative treatment of contacts;
- (d) eliminate tuberculosis in dairy cattle by tuberculin testing and slaughter of reactors;
- (e) boil or pasteurize milk; and
- (f) closely monitor those in contact with infected persons or animals.

4.7 Brucellosis - Detailed Discussion

Brucellosis is an infectious disease caused by the three classical species of Brucella: B. abortus, B. suis, and B. melitensis. Brucella abortus is chiefly an infection of cattle, B. melitensis infects goats and sheep, and B. suis is found chiefly in swine. Cross infections do occur and almost all domestic species are susceptible. Brucella ovis is a new species which produces natural infection only in sheep (Jubb et al. 1985). B. canis infection occurs in dogs but has also been reported in humans. B. neotomae occurs only in wood rats and is apparently non-pathogenic.

Infection is initially systemic, with relapsing bacteremic phases in persisting infections. Localization and persistence of infection may occur in many organs, but most notably the genitalia and placenta. Although Brucella have a wide host range, they are not readily transmitted from preferential to dissimilar hosts, but when this occurs, they usually localize in the mammary gland and reticuloendothelial system rather than in the uterus and fetal membranes (Blood et al. 1983).

4.7.1 Clinical Signs of Brucellosis

Cattle

Brucellosis in cattle (also referred to as Bang's disease or contagious abortion) is caused by infection with B. abortus and is characterized by abortion late in pregnancy and a subsequent high rate of infertility.

In highly susceptible non-vaccinated pregnant cattle, abortion after the fifth month of pregnancy is the cardinal feature. In subsequent pregnancies, the fetus is usually carried to full term although second or even third abortions may occur in the same cow. Retention of the placenta and metritis are common sequelae to abortion. Mixed infections are usually the cause of the metritis which may be acute, with septicemia and death following, or chronic leading to sterility.

In a susceptible herd, the infection may spread rapidly; an abortion storm occurs. This may last for a year or more, after which time most of the susceptible cows have been infected and have aborted and proceed to carry their subsequent calves to full term. As the abortion rate subsides, the abortions are largely restricted to first calf heifers and new additions to the herd (Blood et al. 1983).

Establishment of the carrier state in a large proportion of animals may lead to a 20% reduction in milk yield of infected cows, the production of dead calves at term, and an increased frequency of retained placenta (Seigmund 1979).

In bulls, orchitis and epididymitis occur occasionally. One or both scrotal sacs may be affected with acute, painful swelling to twice normal size, although the testes may not be grossly enlarged. The swelling persists for a considerable time, and the testis undergoes liquefaction necrosis and is eventually destroyed. Affected bulls are usually sterile when orchitis is acute, but may regain normal fertility if one testicle is undamaged. Such bulls are potential spreaders of the disease if used for artificial insemination.

B. abortus can often be isolated from lesions of non-suppurative synovitis in cattle. Hygromatous swelling (bursitis), especially of the knees, and progressive and erosive non-suppurative arthritis of the stifle joints may occur (Blood et al. 1983). It may also be found in cases of purulent tendovaginitis, arthritis or bursitis (Jubb et al. 1985).

Bison

The clinical signs of brucellosis in bison are similar to those in cattle, but the main clinical sign, abortion, may not be observed in wild populations.

Abortions and weak calves have been documented in captive populations by Davis et al. (1986). In that study, four of six (67%) bison experimentally exposed to B. abortus became bacteriologically positive, seroconverted, and aborted or had weak calves that died.

Humans

The incubation period of Brucella in humans varies between 7 and 21 days, although many months may pass between the time of infection and the first appearance of symptoms. The onset of illness is often insidious; patients have a low-grade fever, no localized findings, and complain only of headache, weakness, insomnia, sweats, constipation, backache, and generalized aches and pains. Most patients are anorectic and lose weight. Pregnant women may abort spontaneously. Less common findings include pneumonia, meningitis, epistaxis, and enlarged lymph nodes, spleen and liver.

The course of the illness is variable, ranging from a few days to years in duration. Untreated, the illness usually lasts months, and even with treatment, the patient is often ill for a month or more. Five per cent of patients receiving appropriate therapy have one or more relapses within three years of initial onset, and the relapse rate is higher without proper therapy.

Chronic brucellosis is rare in appropriately treated cases, but chronic manifestations include spondylitis, osteomyelitis and granulomas of the liver, spleen, kidney and heart. One of the more common sequelae seen in humans (when brucellosis was widespread in North American cattle) was valvular endocarditis. The disease also causes arthritis and neurological disturbances.

Other Species

Swine - Pigs are susceptible to B. melitensis and slightly susceptible to B. abortus. The disease in pigs is usually caused by B. suis, and this organism presents important problems in many countries. It does not occur in Great Britain and appears to have been eradicated from Denmark. It occurs in Canada only in reindeer and caribou populations and occasionally in man.

Abortion usually occurs between the second and third months of pregnancy, and the incidence of abortion is relatively less than in the bovine disease. There is

incidence of early undetected embryonic death. Articular lesions caused by B. suis are quite common. Synovitis of the large joints of the limbs, vertebral osteomyelitis, suppurative meningitis and paravertebral abscesses are also seen.

Sheep & Goats - Brucellosis (B. melitensis) in sheep and goats is prevalent in countries bordering the Mediterranean. The caprine disease resembles bovine brucellosis, but the disease in sheep is usually less protracted, and spontaneous recovery is fairly common. As is usual for ruminants, abortion may be the only sign observed. Sheep may also be affected by B. ovis, which rarely causes abortions and is more commonly associated with infertility (Jubb et al. 1985). B. ovis does cause severe epididymitis and orchitis.

Horses - Infected cattle and brucella-contaminated milk are considered the most common sources of infection in horses. B. abortus may cause suppurative, granulomatous inflammations of the atlantal and supraspinous bursae, known as poll evil and fistulous withers. The organism has also been associated with other bursal involvements (navicular lameness) and with lesions of some joints and tendon sheaths (Cattcott and Smithcors 1972). Some horses appear to suffer a generalized infection with clinical signs including general stiffness, fluctuating temperature and lethargy.

Dogs - Dogs are relatively resistant to brucellosis, but natural infections caused by all three species of Brucella do occur. The majority of such infections are asymptomatic and detected serologically. Orchitis and epididymitis have been observed. Brucella canis is also found in dogs and is a serious cause of abortion and epididymitis.

Cats - Cats are resistant to natural infection by Brucella spp.

Other Wildlife - In the United States, antibody titres have been found in wild red foxes, coyotes, black bears, bobcats, skunks, badgers, opossums, raccoons, white-tailed deer, mule deer, elk, bison, and Dall's sheep. B. abortus has been isolated from foxes, coyotes, opossums, raccoon, white-tailed deer, elk and bison. Studies

on diseases in WBNP have found B. abortus in wolves, a fox, bison, and in a severely debilitated moose (Tessaro 1986).

In the NWT, B. suis biotype 4 has been found in man, reindeer, caribou, and in one musk-ox. It is not pathogenic in livestock. Brucella agglutinating titres have been found in caribou, arctic ground squirrels, a moose, grizzly bears, red fox, sled dogs, and wolves (Tessaro 1986).

It is also important to note that serological evidence has not been found in black bear, fishers, martens, lynx, mink or in a variety of rodents sampled in the WBNP area. A 1976 serological survey of diseases in Alberta wildlife did not find Brucella antibodies in 3 wolves, 9 bighorn sheep, 11 snowshoe hares or 22 woodland caribou. Also negative were sera from 146 moose in British Columbia in 1980, 208 moose in Quebec in 1984, and 58 deer in southeastern Saskatchewan in 1948-49 (despite the high prevalence of brucellosis in cattle in that area at the time) (Tessaro 1986).

Elk - Bovine brucellosis is a significant problem in Wyoming elk herds. Approximately 20,000 elk use 22 feeding grounds in the western part of the state. B. abortus biotype 1 has been isolated from aborted elk fetuses and nonviable calves, and from 17 of 45 adult elk at necropsy. About 50% of mature cow elk in the National Elk Refuge and Grays River herds have had serological evidence of infection. Experimentally infected elk maintain active infections for up to 56 months. Horizontal transmission was demonstrated between infected elk and noninfected elk and cattle in the same enclosure, and 14 of 29 infected cow elk either aborted or delivered premature or nonviable calves (Tessaro 1986).

Caribou - Caribou infected with B. suis biotype 4 suffer abortions, metritis, bursitis, arthritis, orchitis, and epididymitis (Tessaro and Forbes 1986).

4.7.2 Transmission of Brucellosis

Cattle

Infection occurs in cattle of all ages but persists most commonly in sexually mature animals. Congenital infection may occur in calves born from infected dams. B. abortus achieves its greatest concentration in the contents of the pregnant uterus, the fetus and the fetal membranes, and these must be considered as major sources of infection.

Transmission is by ingestion, penetration of the intact skin and conjunctiva, and contamination of the udder during milking. Grazing on infected pasture, consuming other feedstuffs and water supplies contaminated by discharges and fetal membranes from infected cows, and contact with aborted fetuses and infected newborn calves are considered to be the most common methods of transmission. Congenital infection due to in utero infection does occur. The organism can survive on grass for variable periods depending on environmental conditions. In temperate climates, infectivity may persist for 100 days in winter and 30 days in summer. The organism is susceptible to heat, sunlight and standard disinfectants, but freezing permits almost indefinite survival.

Bulls do not usually transmit infection from infected to non-infected cows mechanically and are most likely to transmit the disease by discharge of semen containing organisms. The chance of spread from a bull is very great if the semen is used for artificial insemination. Infected animals, almost without exception, excrete B. abortus in the colostrum. Excretion of the organism in milk is usually intermittent but appears to be more common during late lactation and can continue for several years. Few infected cows ever recover completely, and therefore, it is best to consider them as permanent carriers.

The spread of the disease from one herd to another and from one area to another is almost always caused by the movement of an infected animal from an infected herd into a non-infected susceptible herd (Blood et al. 1983). Latent infection occurs in a small percentage of heifer calves that acquire infection in early life,

pass all official blood tests (usually from six months onwards) and yet abort during the first or subsequent pregnancies. At this time, they become actively infected and shed the organism. They may or may not be daughters of infected dams, but they were present in the herd when the last infection occurred. These heifers can cause serious problems in the final stages of disease eradication in herds that have been "free of infection" for two years or more (Crawford and Hidlgo 1977). The disease can also be spread by infected bulls and horses with fistulous withers (Tessaro 1986).

Bison

It is important to note that Agriculture Canada considers domestic bison to be part of the national cattle population.

It may be assumed that transmission in bison is similar to transmission in cattle. Experimentally, cattle have been infected when housed with infected bison (Davis et al. 1986). In another study, vaccinated and non-vaccinated cattle were infected conjunctively with Brucella from bison and aborted or had weak calves that died (Colgrove et al. in prep.).

Human

Human infection results primarily from exposure to Brucella organisms through ingestion, direct contact or inhalation.

Ingestion of unpasteurized dairy products (both cattle and goats) is the primary source of human brucellosis. Those eating raw or undercooked meat may also contract the disease. Contact with infectious material such as uterine discharges, hygroma fluid, or blood is an important source of infection for livestock raisers, veterinarians, and abattoir workers. When the disease is prevalent in game animals, hunters and wildlife officials are also at risk.

Intact skin is an effective barrier against Brucella, but people at risk of infection often have skin abrasions and cuts. Brucella organisms can also readily invade

the body through the conjunctiva if infectious material is rubbed or sprayed into the eyes. Infection can also occur from inhalation of droplets and aerosols, but this is thought to be important only to abattoir workers and those in enclosed environments such as a laboratory.

Other Species

Ingestion or penetration of the intact skin are the normal routes of infection in all species. In sheep with B. ovis, the infection is spread during coitus when infected rams excrete the organism in the semen.

B. suis in swine infects both boars and sows. The boars develop lesions in the testes or accessory genitalia from which the organisms are shed in the semen, often for life. Unlike B. abortus in cattle, B. suis in swine may infect the urinary bladder and organisms will then be shed in urine (Jubb et al. 1985).

In horses, the probable route of infection is through mucus membranes or by ingestion. Infected cattle and Brucella-contaminated milk are considered the most common sources of infection (Catecott and Smithcors 1972).

In dogs, ingestion of contaminated materials is the common method of infection. Dogs may be mechanical spreaders of B. abortus by dragging aborted fetuses or placentas from one area to another. Dogs may also develop cystitis and potentially spread the organism in urine.

It is important to note that although Brucellae have a wide host range, they are not readily transmitted from preferential to dissimilar hosts, and when this occurs, they usually localize in the mammary gland and reticuloendothelial system rather than in the uterus and fetal membranes. Therefore, special circumstances are required for infection of a dissimilar host, and a dissimilar host is unlikely to spread the disease.

Abnormal situations, such as the high concentrations of Wyoming elk on feeding grounds, undoubtedly facilitate transmission. Infection rates of approximately 50%

occur in the National Elk Refuge and Grays River herds, but an infection rate of only about 1% is reported in non-concentrated elk in Montana (Dr. Ferlicka, State Veterinarian, Montana pers. comm.).

In the campaign to eradicate brucellosis in plains bison in EINP, no special effort was made to control brucellosis in elk. In the mid-1950s, 13% of elk tested positive for brucellosis. Apparently due to a population reduction program (not aimed at disease), the elk population dropped from approximately 2000 animals to just a few hundred in the late 1950s, and by 1959, the incidence of brucellosis in elk was 3%. As the disease was gradually eliminated from the bison population, the incidence of brucellosis reactors declined in elk, and it was no longer detected in elk after the disease had been eliminated from plains bison populations (Blyth and Hudson 1987).

4.7.3 Pathogenesis of Brucellosis in Animals

B. abortus has a predilection for the pregnant uterus, udder, testicles and accessory male sex glands, lymph nodes, joint capsules, and bursae. After initial invasion of the body, localization occurs first in the lymph nodes draining the area and then spreads to other lymphoid tissues including the spleen and the mammary and iliac lymph nodes. Congenital infection can occur in newborn calves as a result of in utero infection, and the infection may persist in a small proportion of calves which may be serologically negative until after their first parturition or abortion. In the adult non-pregnant cow, localization occurs in the udder; the uterus, if it becomes gravid, is infected from periodic bacteremic phases originating in the udder. Infected udders are clinically normal, but they are important as a source of reinfection of the uterus and as a source of infection for calves or humans drinking the milk. Erythritol, a substance produced by the fetus and capable of stimulating the growth of B. abortus, occurs naturally in greatest concentration in the placental and fetal fluids and is probably responsible for localization of the infection in these tissues. When invasion of the gravid uterus occurs, the initial lesion is in the wall of the uterus but soon spreads to the lumen of the uterus, leading to a severe ulcerative endometritis. The allantochorion, fetal fluids and placental cotyledons are next

invaded and the villi destroyed. Abortion occurs principally in the last three months of pregnancy, the incubation period being inversely proportional to the stage of development of the fetus at the time of infection. B. abortus is an intracellular organism, and this is probably an important factor in its survival in the host and may explain both the transitory titres occurring in some animals following isolated episodes of bacteremia and the disappearance of titres in animals with latent infections.

Gross Pathology - Brucellosis in Cattle

Necropsy findings in adults are of no importance in diagnosis. In some fetuses, a primary pneumonia is found. The placenta is usually edematous, there may be leathery plaques on the external surface of the chorion, and there is necrosis of the cotyledons (Blood et al. 1983).

Localization occasionally occurs in synovial structures to produce a serous to purulent tendovaginitis, arthritis, or bursitis.

In males, infection may occur in the genital system and accessory glands causing epididymitis and orchitis. Changes in testes may vary from pressure atrophy caused by epididymitis to extensive necrosis of the entire testicle (Amstutz 1980).

Gross Pathology - Brucellosis in Bison

The pathology of brucellosis in bison is believed to be similar to that of cattle. Cases of orchitis and arthritis were observed in WBNP and SRL bison, and B. abortus was cultured from some of these lesions (Diseased Bison Working Group 1986). Lesions caused by brucellosis that have been documented in captive or wild bison include abortions, retained placentas, hygromas, suppurative arthritis, orchitis and epididymitis.

Pathology & Pathogenesis of Brucellosis in Humans

When Brucellae invade the human body they interact with polymorphonuclear leukocytes (white blood cells) and tissue macrophages in the submucosa. Many organisms are destroyed at this point, but if the inoculum is sufficiently large, they spread via the lymphatics to regional lymph nodes, most commonly in the axillary, cervical, and supraclavicular regions. If localization does not occur there, the organisms spread via the bloodstream to other reticuloendothelial tissues such as bones, kidneys, testes, and the endocardium.

The characteristic but non-specific reaction of tissues to Brucellae is the appearance of epithelioid cells, giant cells of the foreign body and Langhans types, and lymphocytes and plasma cells. Granulomas are formed and are usually devoid of caseation or necrosis. Although many Brucellae are killed by polymorphonuclear leukocytes, the macrophage is the cell that ultimately destroys Brucellae.

Gross Pathology - Brucellosis in Other Species

Swine - B. suis may cause lesions similar to B. abortus infection in cattle. Boars are as readily infected as sows, and the majority of infected boars develop lesions in the testes or accessory genitalia. Unlike cattle, infection may also focus in the urinary bladder. Articular lesions caused by B. suis are quite common. Synovitis of the large joints and osteomyelitis in the vertebral epiphysis of the lumbar region are typical.

Horses - Lesions in horses are generally identified as poll evil and fistulous withers. Each is a suppurative, granulomatous bursitis with a distinct tendency to produce fistulae on the skin (Jubb et al. 1985).

Others - Reindeer and caribou in Alaska and Russia infected with B. suis have been observed with orchitis, epididymitis, bursitis, mastitis, supraspinous bursitis, metritis, and abortion or retained placenta. In Canada, B. suis has been isolated from caribou with carpal bursitis, from one caribou with granulomatous nephritis, and one musk-ox with carpal bursitis (Tessaro 1986).

4.7.4 Prognosis - Brucellosis in Animals

In a susceptible cattle population just acquiring infection, the prognosis for the in utero calves is very poor; about 80% of them may be aborted or born weak. If the herd had been vaccinated with Strain 19, the abortion rate would be much lower (Amstutz 1980).

Once the initial abortion storm is over, it is likely that only new additions to the herd and heifers will abort. The herd will also experience an increase in the occurrence of retained placentas and some increase in infertility caused by metritis.

The prognosis for the individual cow is good in that the animal is unlikely to die from the disease. However, once infection is established in sexually mature animals, especially females, it tends to persist indefinitely. Few infected cows ever recover completely, and they should be considered as permanent carriers of infection, whether or not abortion actually occurs. The prognosis for the herd is poor as neither treatment nor vaccination will eliminate the disease, and invariably a test and slaughter program must be initiated to clean up the disease.

4.7.5 Control Strategies - Brucellosis in Animals

Vaccination

Bovine brucellosis in a domestic cattle herd may be controlled with an effective vaccination program or eradicated using a test and slaughter program. Vaccination using Strain 19 will reduce the prevalence of abortion markedly, but the level of infection will not be reduced at a corresponding rate. Even with a widespread vaccination program, there will be foci of infection that persist indefinitely.

The advantages and disadvantages of calfhood vaccination in cattle are summarized as follows:

Advantages:

- (a) the vaccine will prevent abortion in approximately 70% of exposed vaccinates;
- (b) one vaccination will protect most animals for their normal reproductive life;
- (c) if administered at the proper age, vaccine causes minimal interference with later serological testing;
- (d) administration of the vaccine causes insignificant systemic or local reactions in most animals;
- (e) the organism in the vaccine is stable and will not revert to original virulence; and
- (f) vaccinates have some advantages with respect to their movement in Canada. Some states in the United States require that imports be vaccinated.

Disadvantages:

- (a) the Strain 19 vaccine is a live product; its effectiveness is impaired by improper storage and handling;
- (b) protection is not complete;
- (c) persistent infection may occur in vaccinates;
- (d) some vaccinated animals retain detectable serological titres, even though vaccinated at the lower age limit;
- (e) the assembling of calves for vaccination at the prescribed age is difficult under certain animal husbandry systems;
- (f) the vaccine is a potential health hazard for persons administering it;
- (g) some countries will not accept vaccinates (Agriculture Canada, no date); and
- (h) Strain 19 vaccine may not work in species other than cattle and can induce abortion in bison (S. Tessaro, pers. comm.).

In most control programs, vaccination is usually permitted up to 12 months of age (8 months in Canada), but the proportion of persistent postvaccinal serum and whey reactions increases with increasing age of vaccinates. Such persistent reactors may have to be culled in an eradication program. Vaccination of adult cattle is usually not permitted if an eradication program is contemplated, but it

may be of value in reducing the effects of an abortion storm. There is no evidence that vaccination of bulls has any value in protecting them against infection, and vaccination has resulted in the development of orchitis and the presence of B. abortus Strain 19 in the semen (Amstutz 1980).

These programs are not particularly effective in wild populations because of the logistical difficulties involved in capture.

Eradication

Complete eradication of brucellosis is the alternative to control by vaccination. Some countries have already achieved brucellosis-free status, and others are currently engaged in eradication programs. The Channel Islands succeeded in 1935, Norway in 1952, Sweden in 1957, Finland in 1960, Denmark in 1962, Czechoslovakia in 1964, and the Netherlands in 1967. Canada became brucellosis-free in 1985. Australia, New Zealand, the United Kingdom, and the USA are actively working towards eradication in the 1980s.

Vaccination cannot eradicate brucellosis, but it may be used to decrease the infection rate to a level at which a test and slaughter program is feasible.

Test and slaughter programs are usually based on serum tests conducted during farm-to-farm testing, from slaughter houses and from auction marts. In addition, testing of dairy herds can be accomplished by milk and cream ring tests of bulk samples.

In most countries, vaccination was prohibited prior to eradication.

4.7.6 Treatment - Brucellosis in Animals

Treatment of animals with brucellosis is not usually undertaken. Trials using bovine plasma, sulfadiazine, streptomycin and chlortetracycline given parenterally, and the latter two as udder infusions, have been unsuccessful in eliminating the infection.

Horses with fistulous withers and positive serum agglutination tests are commonly treated by vaccination with B. abortus Strain 19. In the United Kingdom, an equine brucellosis vaccine is used for the purpose. Chloramphenicol is reported as a successful treatment in infected horses (Amstutz 1980). Agriculture Canada recommended slaughter of in-contact horses at the Vermilion outbreak. Two horses were seronegative but culture positive, which suggests the serology is not accurate in horses.

4.7.7 Treatment & Prevention of Brucellosis in Humans

Treatment

It is generally accepted that the combination of tetracycline (500 mg orally four times daily for six weeks) plus streptomycin (1 mg intramuscularly for two weeks) will cure brucellosis in humans. This regimen has produced lower relapse rates than treatment with tetracycline alone. Chloramphenicol and rifampin are alternative drugs, but the tetracycline/ streptomycin combination has proven to be the superior treatment.

Prevention

No vaccine is available for humans in the USA or Canada although a promising vaccine against B. abortus is available in France. Protection afforded by prior infection appears to be in the range of 90%.

People at risk should be educated about the disease, its symptoms, how it is acquired, and the need for early diagnosis and treatment. The importance of safe handling procedures, good personal hygiene, and appropriate protective equipment must be stressed.

4.8 Eradication and Control of Bison Disease in Canadian and U.S. National Parks

4.8.1 Elk Island National Park - Plains Bison

The Elk Island plains bison population has fluctuated between 500 and 2500 animals; between 1907 and 1984 the average population was about 840 (Blythe and Hudson 1987). Between 1929 and 1945, over 3000 animals were inspected at slaughters for tuberculosis and over 2000 tested for brucellosis, and no sign of disease was found until the winter of 1945-46. At that time, 6 of 400 slaughtered bison were found to have granulomatous, tuberculosis-like lesions. There is no record of these lesions being cultured, so it is not known if the animals were indeed infected with Mycobacterium spp. In January 1947, all 1049 bison in the herd were tested and found negative for tuberculosis.

Later that same winter, a small test of 37 bison demonstrated a 16% incidence of brucellosis. By the mid-1950s, 43% of the plains bison tested positive for brucellosis. In addition to plains bison, 13% of the elk tested were positive, and the disease was also found in two moose that were shot because they were obviously ill.

In an attempt to eliminate disease from the park's plains bison herd, a new area of land added to the park south of Highway #16 was designated as an isolation area. Each year, bison were tested for TB and brucellosis, and those with negative test results were shipped to the fenced isolation area. This plan did not produce a disease-free population, and soon herds in both the main park area and the isolation area had brucellosis. A test and slaughter program in the 1950s did not improve the situation, and by 1959, the incidence of brucellosis in plains bison in the park was 52%. This situation was attributed to negative test reactions in animals that were either incubating the disease or harbouring latent infections.

In the late 1950s, a new park policy to reduce large ungulate populations in the park (regardless of disease) was undertaken. Between 1958 and the early 1960s ,

Elk Island's bison, elk and moose populations were all reduced from approximately 2000 each to a few hundred each. This reduction in population alone appears to have reduced the incidence of brucellosis in elk from 13% in the mid-1950s to 3% by 1959, probably because of lower density in the elk population and fewer infected bison in the area.

In the early 1960s, all plains bison calves were rounded-up each spring, vaccinated with Strain 19, and branded for identification. This vaccination of calves and some yearlings went on for four or five years, at which point many age classes had been vaccinated; by the fall of 1964, the incidence of brucellosis had been reduced to 21%. To produce a completely vaccinated herd, slaughters were then conducted to remove the older, non-vaccinated age classes. During the winter of 1965, all plains bison not rounded-up and tested were shot in the field. By this time, the total bison population was 493 head. In addition, testing in both spring and winter was undertaken in 1965 and 1966. Animals were identified with Health of Animals ear tags and held in corrals pending test results. Slaughter of reactors and non-vaccinated animals continued in conjunction with twice-yearly testing. This appeared to hasten the elimination of brucellosis. By January 1969, only two suspected cases were recorded, and EINP was unofficially declared brucellosis-free (Blyth and Hudson 1987).

Throughout the entire campaign to eliminate brucellosis from the park, no special effort was made to round up and destroy reactors in elk or moose populations. As the disease was gradually eliminated from the bison population, the incidence of brucellosis reactors also declined in elk and moose. The disease was no longer detected in these species after it had been removed from the plains bison population.

Tuberculosis tests were done in conjunction with most brucellosis tests. These tests had all been negative until four positive reactors occurred in a group of plains bison being assembled for shipment to Newfoundland in 1964. Intensive testing followed, but failed to detect any positive tuberculosis reactors or suspects in the entire herd. The four reactors were slaughtered, but it is not known if any lesions were found. Since then, tuberculosis has not been found in the park's

plains bison. It has been suggested that these may have been sensitivity reactions caused by exposure to Mycobacterium avium through the feeding of hay from local farms to the park bison herd (C. Blyth, pers. comm.). This hay was supplied and fed by local farmers who maintained their own cattle herds. A possible source of infection and the means of transporting it did exist, but this cannot be confirmed.

4.8.2 Elk Island National Park Wood Bison

In August 1965, 23 apparently disease-free wood bison were brought from WBNP to EINP; 3 more calves were moved to Elk Island over the next 18 months. An intensive semi-annual testing program was instituted and brucellosis and tuberculosis reactors were found at each test.

In March 1969, two herds were created. One herd was made up of all the original bison from WBNP and a second separate herd was comprised of those animals born in EINP to the original WBNP wood bison. Male reactors were slaughtered, female reactors were allowed to calve and then were slaughtered and the calves were hand-reared. By November 1969, all the original bison had been destroyed, with the exception of two calves from WBNP, which were bottle fed with the Calves Born in Elk Island herd.

In April 1970, tuberculosis and brucellosis tests on this herd were negative and have remained negative subsequently. By 1976, the herd numbered 116 and formed the nucleus for the National Wood Bison Recovery Program in Canada (Dixon and Henderson 1977).

4.8.3 Buffalo National Park - Wainwright, Alberta

At Buffalo National Park, bison were pastured with cattle and cattalo. Slaughters revealed tuberculosis infection rates as high as 75% in bison. Infections caused by Mycobacterium bovis were found in approximately 6% of elk, 6% of moose, and 1% of mule deer that ranged with the infected bison (Tessaro 1986).

By the 1920s, the bison and other ungulate populations were rapidly exceeding range capacity in the park, and between 1925 and 1928, 6673 bison were shipped by barge to WBNP. Annual slaughters continued at Wainwright for population control, and by 1939, about 14,000 bison had been slaughtered. With an annual kill averaging 1300 head, the government realized it had unintentionally begun a commercial bison farm and it wanted to close the park.

With the outbreak of war in 1939, the Department of National Defence applied to use Buffalo Park for military operations. In November and December 1939, park marksmen shot all the ungulates in the park and hauled them to an abattoir. In total, 2918 bison, 1806 elk, 113 moose, and 242 deer were slaughtered. No further tuberculosis infections in wildlife have been found in this area.

4.8.4 Yellowstone National Park Bison Herd

Herd Management

Yellowstone National Park has a large free-ranging plains bison population of approximately 2500 animals. There are no internal or boundary fences, and there is no hunting within the park.

The park was created in 1872 in part to protect wild bison that inhabited its most remote areas. In 1902, bison from two captive herds were introduced, and the wild and ranched animals intermingled, interbred, and increased in numbers.

Between the mid-1950s and mid-1960s, the park regulated population size by occasional removals of bison through field shooting, live shipment, and slaughter. Since 1966, the Yellowstone bison have been subject only to the various natural regulatory factors of the habitat and environment in which they live.

Winter kill apparently serves as the primary population regulator, removing the older and the weaker animals during more severe winters. Predators do not seem to have much influence on bison numbers. Only wolves are competent predators of bison, but they are no longer present in the Yellowstone area.

Conflicts with private lands preclude the re-establishment of bison outside the park. The park's biological management approach involves natural regulation within the park, but recognizes a population segment outside that is in conflict with other human activities. This segment is managed actively with the cooperation of the several agencies involved. Although live shipment of bison is not possible because of brucellosis in the population, removals by hunting and by agency personnel in some locations may minimize conflicts yet ensure perpetuation of the bison within the park in a natural state (Meagher 1985).

Disease Management

Brucella abortus was first reported in the bison of Yellowstone National Park in 1917 (Meyer 1966). From 1930 to 1933, 305 of 484 bison (63%) killed in herd reductions in the park were seropositive for brucellosis. Sera obtained from live bison during the same period yielded 59 reactors from 82 animals (Tunncliff and Marsh 1935).

Yellowstone Park files show that in the 1984-85 hunt of stray animals from the park, 88 animals were shot, 38% were reactors, 17% suspicious, and 45% negative. Of 57 animals killed in 1986, 27% were brucellosis reactors, 16% were suspects, and 57% were negative.

There are many sides to the disease management issue at Yellowstone. Some park personnel do not believe there is any danger of cattle acquiring brucellosis from infected bison; others including ranchers and veterinarians are concerned about the potential for such infections; animal rights groups have taken park authorities to court (unsuccessfully) for their use of hunting as a bison control method.

The following statement by the U.S. Department of the Interior summarizes the government position on eradication of brucellosis in Yellowstone (U.S. Department of the Interior 1985):

"Concern has been expressed that domestic cattle may become infected with brucellosis by coming in contact with Yellowstone bison when movements outside park boundaries occur. We appreciate this concern, and the need to protect domestic livestock from potential infection with Brucella organism, as well as to prevent other conflicts on private lands.

Brucellosis in the bison population of Yellowstone National Park presents a unique management problem. The Yellowstone bison represent the only surviving remnant of wild, undomesticated bison in the United States. Maintaining the integrity of this bison population, including its genetic, behavioral, and distributional characteristics, must be a primary consideration in the design of a Yellowstone brucellosis control program. Brucellosis eradication methods have been designed to meet conditions found on domestic cattle ranches. Applying these methods to a wild bison population would irrevocably, and we believe needlessly, destroy the scientific and cultural values of this significant wildlife resource. Moreover, because brucellosis is present in elk in the Yellowstone area and has been reported from a wide variety of host species, it appears highly unlikely that eradication is possible even with removal of all bison.

Present information indicates that transmission of the Brucella organism between free-ranging bison and domestic cattle is a theoretical possibility rather than a biological problem in this area. No occurrences of brucellosis in nearby cattle have been traced to park bison. Adjacent areas of Montana where most bison movements occur have been brucellosis-free for 20-25 years.

Brucellosis appears to be a natural endemic disease of bison. That is, the Yellowstone bison population is adjusted to the disease, and its eradication is not essential to maintain the health and survival of the bison.

We believe that maintaining a physical separation between domestic cattle and the wild bison of Yellowstone will be effective in protecting livestock. To ensure this, we have developed a boundary control program which involves monitoring bison movements and, as circumstances warrant, dispatching some animals in problem locations. In cooperation with personnel of the department of Fish, Wildlife, and Parks of Montana and with the implementation of their permit hunting season, this goal of separation can be achieved. Comparable programs in cooperation with the states of Idaho and Wyoming appear feasible where necessary."

In a resolution passed in October 1986, the United States Animal Health Association urged the Department of Interior, National Park Service to actively and in good faith cooperate with the United States Department of Agriculture, Animal and Plant Health Inspection Service, Veterinary Services:

1. to discuss and evaluate the bison brucellosis problem in Yellowstone National Park,
2. to fund field trial and research projects directly applicable to solving this problem, and
3. to study ways and make plans to contain and eliminate the reservoir of brucellosis that exists in Yellowstone National Park and to expeditiously put these plans into effect.

The Animal and Plant Health Inspection Service (APHIS) seems to be understanding and cooperative with the National Park Service and the Department of the Interior. APHIS believes the most practical and feasible long-term solution to this problem is the control and eventual eradication of brucellosis from bison in the park. They are working with the Wyoming Game and Fish Department and the University of Wyoming to field test a bio-bullet system for vaccination. Once the infection rate has been reduced by vaccination, other proven procedures will be used to eliminate the last vestiges of brucellosis in the herd.

4.9 Conclusions

4.9.1 Potential of Control

It is clear in the literature that, although brucellosis and tuberculosis may infect a large number of animal species under the right conditions, control of the disease is achieved by its control in the main host species. Agriculture Canada has essentially eradicated tuberculosis and brucellosis throughout Canada (in a wide variety of conditions and environments) by concentrating on eradicating the disease in the main host species.

Brucellosis and tuberculosis share a wide range of potential wildlife hosts. However, field surveys on free-ranging populations have only rarely found infected

individuals, and most of these animals had been in contact with infected cattle. There are a few important exceptions to this generalization. In North America, bison and elk have been, and are, important reservoirs of brucellosis and tuberculosis. In the presence of primary reservoirs, other wildlife species can contract the diseases and may secondarily be important mechanical or biological vectors (Tessaro 1986).

4.9.2 Potential Infectivity to Cattle

From the agricultural point of view, the most important questions to be answered are "Will tuberculosis or brucellosis spread from bison to cattle?" and "Is there really any danger to cattle from infected bison?" Colgrove et al. (in prep.) concluded:

"Brucella abortus, isolated from bison, is capable of infecting both unvaccinated and vaccinated cattle by the conjunctival route. Parturient cows so infected shed the organism in placenta, milk, and vaginal secretions. By this means, B. abortus was transmitted to a vaccinated contact cow and to a calf, born to uninfected dam, which suckled on an infected cow. Deaths occurred in calves born to both uninfected and infected dams; however, there can be little doubt that a large study would reveal a higher rate of neonatal deaths and abortions in cows infected with B. abortus of bison origin than in uninfected animals".

Davis et al. (1986) found that cattle developed brucellosis when housed with infected bison. They also reported that certain behavioural patterns in bison tended to decrease the potential exposure of cattle to the disease - i.e. bison cows were extremely protective of their calves, they guarded aborted fetuses, and readily consumed the placenta.

Thoen et al. (1986) reported tuberculin skin test reactions in penned cattle in contact with infected bison. Post mortem examinations revealed no lesions in the penned contact cattle at 11 months post exposure, however the researchers involved believed that lesions would have developed if the study had been extended.

Well-documented epidemiological studies on American domestic bison herds and park herds in the USA and Canada have determined that the bison-to-bison spread of brucellosis and tuberculosis occurs readily. The results of these studies also provide evidence that the diseases can be transmitted from bison to cattle. In Canada, the diseased hybrid bison of northern Alberta and the NWT pose a serious threat to the Canadian cattle herd as well as the wood bison of the Mackenzie Bison Sanctuary, both of which are currently considered to be free of brucellosis and tuberculosis (L.B. Forbes, Agriculture Canada, pers. comm.).

A differing point of view is expressed in a recent review of the role of wild North American ungulates in the epidemiology of bovine brucellosis (McCorquodale and DiGiacomo 1985). That paper concludes that there have been no published reports of wild ungulates hindering the eradication of bovine brucellosis in any part of the world. While this is true, it is important to place the statement in the context that very few countries in the world have eradicated brucellosis, and at the time the above-mentioned paper was written, no country in the world with a significant wild ungulate population had successfully eliminated the disease. Since that time, Canada has eradicated bovine brucellosis.

McCorquodale and DiGiacomo (1985) confirm that the only wild ungulates in North America of concern in this regard are bison; they also acknowledge a problem in the Wyoming elk herds. They suggest that bison rarely leave Yellowstone National Park, and that if they do, the active patrol and elimination program is effective in preventing contact between infected bison and livestock. Due to the remoteness and size of WBNP, it is unlikely that a similar program could be effective there. McCorquodale and DiGiacomo (1985) do not address the additional complication presented by the presence of tuberculosis in Canadian hybrid bison.

The USA has not yet achieved eradication of brucellosis in livestock. Their efforts are directed at cattle reservoirs, as were Agriculture Canada's efforts prior to achieving disease-free status in 1985. However, the eradication of brucellosis, whenever it occurs, makes any subsequent regional occurrence very significant.

In Canada, concern is focussed in two areas - disease transmission to cattle and disease transmission to wood bison. It is unlikely that active patrols around WBNP would be feasible, and failure to prevent disease transmission would be disastrous to the health status of the MBS population and to any future efforts at disease elimination.

4.9.3 Education and Danger to Human Health

The effects of brucellosis and tuberculosis in humans have been described previously. A few local hunters who worked in the Hay Camp and Sweetgrass slaughter houses in the 1950s are aware that these diseases exist, and some of them know where to look for tuberculosis lesions and how to identify them. Since that time, veterinarians from Agriculture Canada and the Canadian Wildlife Service have, when the opportunities arose, shown hunters the signs of disease, but there has been no formal effort to warn or teach the people at risk about the dangers of exposure. This may be due in part to the fact that tuberculosis or brucellosis in humans in the area has not been traced to infected bison. The experiences of abattoir workers and veterinarians, however, indicate that the dangers are very real and also quite difficult to eliminate.

4.10 Implications of the Presence of Tuberculosis and Brucellosis in Bison in the Area of Concern

4.10.1 Potential Impacts on Bison

The September 1986 Report to the Steering Committee from the Diseased Bison Working Group (Appendix I) summarized the bison populations affected by the diseases or at risk of infection as follows:

- a) approximately 4200 free-ranging hybrid bison in WBNP in which the prevalence of brucellosis is about 36% and the prevalence of tuberculosis is also about 36%;
- b) approximately 200 free-ranging hybrid bison in the SRL between Grand Detour and Hook Lake, infected with both diseases at rates similar to bison in WBNP;

- c) about 1600 free-ranging wood bison in the MBS that are believed to be brucellosis- and tuberculosis-free;
- d) 42 disease-free wood bison held under fence near Hay-Zama lakes, Alberta for eventual release as part of the Wood Bison Recovery Program;
- e) 28 disease-free wood bison that range freely in the Nahanni-Liard river area;
- f) one privately owned disease-free herd of 250 plains bison located north of Fort Vermilion;
- g) an unknown number of hybrid bison that have strayed from WBNP toward the Fort Vermilion area. They are believed to have the same incidence of infection as the WBNP herd. Only six of these animals have been examined; one was found to be infected with brucellosis (S. Tessaro, pers.comm.); and
- h) stock on a proposed SRL bison ranch, currently under consideration by the GNWT.

The possibility of infection of Canada's wood bison herds, particularly those from the MBS, is the greatest potential impact of diseased bison on wildlife populations. Wood bison are nationally and internationally recognized as an endangered species. Approximately 75% of the world population is in the MBS, the only well-established free-ranging herd.

Contact between diseased hybrids and the wood bison populations would result in both disease and genetic contamination. With its rapid growth, the Mackenzie wood bison herd has expanded its range to 11,600 km². The danger of the two herds contacting is present and increasing.

4.10.2 Agricultural Considerations

Livestock at Risk of Infection

The September 1986 Report to the Steering Committee from the Diseased Bison Working Group (Appendix I) reported the following livestock populations to be at risk.

- a) There are small cattle operations on Ryan Island, Alberta, adjacent to WBNP and in the Slave River valley on the eastern park boundary. One herd from Hay River ranges close to the Alberta border.
- b) There are small herds of horses at Jean D'Or Prairie, Fox Lake, Fort Smith, Hay River and Fort Resolution.
- c) In the Fort Vermilion Agriculture Zone, there are 2500 head of cattle in 90 herds east of High Level, Alberta. There are 300 head of cattle in 10 herds between Fort Vermilion and the WBNP boundary. Local cattle numbers vary widely from one year to the next. Other livestock in the Fort Vermilion area include 500 - 1000 horses, 2000 - 3000 pigs, 200 sheep and 300 goats.
- d) There are about 3500 head of cattle in the La Crete area, south of Fort Vermilion.
- e) The Fort Vermilion Grazing Reserve, 15 miles north of Fort Vermilion, had approximately 2000 head of cattle committed for the 1986 grazing season. These cattle are from the Fort Vermilion, Provost, Camrose and Ardrossan areas. Contamination of these cattle could spread the diseases throughout Alberta.
- f) The GNWT is encouraging the development of small swine operations. If a bush farmer should feed diseased bison to swine, serious disease problems could arise.

Economic Impacts

The cost of abandoning the tuberculosis and brucellosis eradication programs was estimated by Agriculture Canada in 1978 to be more than \$1 billion over the next twenty years. If the current disease situation remains, and Agriculture Canada retains the Market Cattle Testing (MCT) Program in northern Alberta as a

surveillance method to assure no infection is coming from this area, the cost to Agriculture Canada is estimated to be:

-	Minimum of 9 person years	\$243,000
-	Mustering fees-auction marts	136,300
-	Contract bleeding	42,250
-	Supplies	43,750
-	Overtime & meals	30,000

TOTAL COST PER YEAR		\$495,300
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This total of \$495,300 to maintain MCT coverage in northern Alberta does not include transportation costs, and barring unforeseen events, it summarizes the economic impact of the present situation.

However, if these diseases were to spread, Alberta would be the province most affected. Alberta is the largest cattle producing province in Canada, accounting for 39.2% of the beef cow population and 29.9% of total Canadian cattle and calves in 1985. In Alberta, cash receipts from the sale of cattle and calves account for 28.9% of total farm receipts (compared to a national figure of 17.4%). Alberta production of cattle and hogs is significantly in excess of provincial consumption requirements. Export, in various product forms, is a necessary and integral part of both industries. Without access to markets in Canada and the USA, production would fall to a fraction of current levels and would have a severely negative impact on the provincial economy.

The value of this trade is reported as follows:

- in 1984, the value of Alberta's exports of live cattle to the USA was \$85 million; total Canadian exports of live cattle that year to the USA were \$231 million and in 1986, they were \$213.6 million;
- in 1984, semen exported to the USA from Alberta was valued at \$500,000;
- in 1984, Alberta exported \$56 million in red meat (\$41 million beef) to the USA; total Canadian red meat beef exports in 1986 were valued at \$219.5 million;
- in 1986, Canada's total semen and embryo exports were \$16 million.

The meat/livestock industry in Alberta at present employs more people than any other industry, about 5500, and is second only to the oil and gas industry in dollar revenue. In 1982, the value added by meat packers in Alberta was \$202 million. The industry directly employed 4256 people and had a payroll of over \$1 million in 1982. Shipments were valued at \$1.8 billion (T. Church, Alberta Agr., pers. comm.).

Agricultural Trade

A small rise in the incidence of tuberculosis or brucellosis in Canada would have little impact on exports as long as areas were maintained as brucellosis- and tuberculosis-accredited. If areas lost their accredited status, Canada would face restrictions on the export of cattle, semen and embryos in the world market, and countries such as Great Britain, Ireland, Sweden, Norway, and Denmark would probably place a ban on the importation of Canadian cattle. Export test requirements for the USA would become more stringent. The importation of Canadian beef and beef products would be greatly reduced by some importing countries.

Province-wide spread of disease from the Fort Vermilion grazing lease could result in the quarantine of a large number of herds in Alberta (and potentially other parts of Canada) and restrictions on the movement of cattle from certain areas. At such times, rumours about the disease situation can do untold damage to the provincial agricultural industry. In such circumstances, continual testing to prevent the spread of disease could inconvenience patrons of a grazing lease, perhaps resulting in collapse of the lease, use of private leases, and some loss of knowledge of cattle movements.

Provincially, the greatest impact of the spread of disease would occur in the live cattle markets and in sales of breeding stock. Canada's present freedom from disease means that tuberculosis and brucellosis testing is required only of exported beef cattle, not the whole herd of origin. Animals vaccinated for brucellosis and less than 18 months of age are only tested for tuberculosis. At least 22 states require breeding females to be vaccinated for brucellosis prior to

six months of age. Dairy breeds also must be tested for tuberculosis and brucellosis. Now that Western Canada has been declared brucellosis-free only one test is required. Each year up to 300,000-350,000 live feeder and slaughter cattle may be moved from Alberta to other provinces and the United States. Disruption of the smooth flow of cattle into other areas would have negative consequences for Alberta producers. Increased testing requirements for export trade would increase the costs to the producer significantly.

Agriculture Canada's export section expressed their concerns to the Task Force in a memorandum entitled: "Impact of Persistent Incidence of Brucellosis and Tuberculosis in Bison on Export Capability" (C. Lavigne, pers. comm.). The memo states that the USDA is closely monitoring Canada's efforts with regard to the WBNP disease problem but that no further international impacts have occurred or are expected in the immediate future.

However, the potential impact of a persistent presence of disease cannot be ignored. The presence of this reservoir of infection in the WBNP area undermines Canada's efforts towards international recognition as a brucellosis- and tuberculosis-free country. It results in persistent demands for testing, which have resource implications for both the Veterinary Inspection Directorate and Animal Pathology Division, and calls into question the credibility of Canada's Animal Health program and ability to provide an acceptable level of health certification. It is without doubt the issue of credibility of certification and international scrutiny of the integrity of the Animal Health Program infrastructure that will ultimately determine the full extent of the export implication. The commercial reality will be felt by the burgeoning game farming industry as an obstacle in fulfilling their export potential. The concern of the domestic livestock export industry with respect to the risk posed, cannot be overemphasized. Complete freedom from these diseases in all domestic stock and wildlife species in Canada would allow Canada to negotiate the elimination of brucellosis and tuberculosis testing for exported cattle, elk and bison and for semen and embryo donors which currently costs farmers approximately \$600,000 per year.

Concern will undoubtedly increase because of the recent biotype 2 isolate in a beef cow in Alberta, a type also found in WBNP bison. The industry can be expected to apply political pressure to the strongest degree to protect their access to international markets against any perceived threat on the domestic level (C. Lavigne, Agr. Canada, pers. comm.).

Local Agricultural Development

Recently, the rate of agricultural development in northern Alberta has declined because of the increased availability of land at reasonable prices in the south and general economic conditions. Development has not been affected greatly by the diseased bison situation. However, provincial land use agencies have already designated areas for agricultural development (e.g. Jean D'Or Prairie), and land will be made available as demand rises, without consideration of a diseased bison problem (M. Miller, Alta. Agr., pers. comm.).

Local farmers and veterinarians in the Fort Vermilion area have sent letters to their MP expressing concern about the disease problem and its potentially adverse effects as development in the area increases.

The fact that bison from WBNP cross park boundaries in the Peace River corridor on the southwest side is a serious threat to the health status of the provincial cattle herd. In past winters, bison have been spotted in the Lake Wentzel area of the Caribou Mountains. The potential exists for widespread transmission of these diseases to other Alberta cattle and bison herds. This would jeopardize Canada's brucellosis- and tuberculosis-free status, established at a cost of \$350 million and has the potential to disrupt cattle marketing in Alberta.

Recent experiences with small isolated occurrences of tuberculosis and brucellosis in central Alberta have demonstrated that cattlemen generally are very concerned about these diseases and most emphatically wish to retain their disease-free status. An outbreak of either of these diseases would have significant consequences for local and provincial markets for cattle. On a local basis, cattle producers would lose market flexibility and suffer reduced returns because of

restricted movement and increased costs associated with the testing necessary to eradicate the diseases. An outbreak of either brucellosis or tuberculosis has serious consequences for individual farmers whose herds are affected. These herds are subjected to quarantine, and subsequent testing usually results in depopulation of the entire herd. Although Agriculture Canada maintains a compensation program, many cattlemen resent and bemoan the loss of the herd genetics often built up over a lifetime.

4.10.3 Humans at Risk of Infection

Bovine Tuberculosis: People who ingest raw unpasteurized milk or dairy products from cattle infected with tuberculosis are at risk. Farmers and animal handlers have also become infected through airborne spread, and this mode of transmission could also affect wildlife officials involved in the management of diseased bison. Eating of raw or undercooked meat from diseased animals may also result in infection, but such cases are rare. The lack of sanitary facilities available to hunters puts them at risk of infection when skinning and butchering infected bison carcasses.

Brucellosis: Bison hunters and wildlife officials who are involved in the slaughter of diseased bison or the disposal of diseased carcasses are at risk of contacting brucellosis unless proper handling and hygiene procedures are followed. Consumers of raw or undercooked Brucella-infected meat are also at risk of contracting the disease.

Contact with infectious material such as uterine discharges or blood is an important source of infection for livestock raisers, veterinarians, and abattoir workers. Hygroma fluid is also a significant source of Brucellae.

Strain 19 vaccine (the only approved brucellosis vaccine in Canada) is a potential source of infection for veterinarians and cattlemen.

4.10.4 Risks to Other Wildlife

"Brucellosis and tuberculosis share a wide range of potential wildlife hosts. However, field surveys on free-ranging populations have only rarely found infected individuals and most of those cases had been in contact with infected cattle. There are a few important exceptions to this generalization. In North America, bison and elk have been, and are, important reservoirs of bovine brucellosis and tuberculosis. In the presence of primary reservoirs, other wildlife species can contract the diseases and may secondarily be important mechanical or biological vectors". (Tessaro 1986).

Tessaro (1986) has isolated B. abortus from four wolves, a red fox, and a moose in WBNP, where these represent satellite infections from bison. Brucellosis appears to be a serious, usually fatal disease in moose, but appears to have limited effect on other wildlife.

Bovine tuberculosis has not been detected in any wildlife species except bison in and around WBNP.

Canadian caribou (Rangifer tarandus) are not known to carry B. abortus or tuberculosis though they theoretically could also contract these diseases from hybrid bison. Their degree of susceptibility and the likelihood of transmittal of disease are unknown.

4.11 Glossary Of Terms

Anorectic - having no appetite

Ataxic - lacking coordination

Bacteremic - pertaining to the presence of bacteria in the blood

Bursitis - inflammation of the bursa

Caseation - a form of necrosis in which the tissue is changed into a dry, amorphous mass resembling cheese

Chorion - the outermost envelope of the growing zygote or fertilized ovum which serves as a protective and nutritive covering.

Conjunctival - pertaining to the membrane that lines the exposed surface of the eyeball

Cystitis - inflammation of the urinary bladder

Edematous - pertaining to the presence of abnormally large amounts of fluid in the intercellular tissue spaces of the body

Encephalitis - inflammation of the brain

Endocarditis - inflammation of the endothelial lining membrane of the heart

Endogenous - developing or originating within the organism

Endometritis - inflammation of the lining of the uterus

Epididymitis - inflammation of the elongated cordlike structure along the posterior border of the testis

Epistaxis - nosebleed

Exogenous - developing or originating outside the organism

Granuloma - a tumor or neoplasm made up of granulation tissue

Gravid - pregnant

Hematogenous - produced or derived from the blood

Hemoptysis - the expectoration of blood or blood stained sputum

Hepatic - pertaining to the liver

Hydropericardium - abnormal accumulation of serous fluid in the sac around the heart

Hygroma - a sac, cyst or bursa distended with a fluid

Hyperesthesia - abnormally increased sensitiveness of the skin or an organ of special sense

Intramammary - within the breast or udder

Intrauterine - within the uterus

Lardaceous - resembling lard

Lymphadenitis - inflammation of the lymph nodes

Lymphocyte - type of white blood cell

Lymphohematogenous - disseminated by the circulatory and lymphatic systems

Lymphokines - a substance that attracts white blood cells

Macrophages - a large mononuclear wandering phagocytic cell which originates in the tissues

Meningeal - of or pertaining to the membranes that envelop the brain and spinal cord

Meningitis - inflammation of the three membranes that envelop the brain and spinal cord

Metastatic - pertaining to the transfer of disease from one organ or part to another not directly connected with it

Metritis - inflammation of the uterus

Miliary - the formation of lesions resembling millet seeds (often widely disseminated).

Necrotic - pertaining to or characterized by death of tissue

Orchitis - inflammation of a testis

Osteomyelitis - inflammation of the bone caused by a pus-producing organism

Paravertebral - beside the vertebral column

Parenchyma - the functional part of an organ

Paresis - slight or incomplete paralysis

Peracute - excessively acute or sharp

Peritoneum - serous membrane lining the abdominopelvic walls

Peritonitis - inflammation of the serous membrane lining the abdominopelvic walls and investing the viscera

Phagocyte - any cell that ingests microorganisms

Polymorphonuclear leukocyte - type of white blood cell

Premonitory - serving as a warning

Purulent - consisting of or containing pus

Recrudescence - relapse

Renal - pertaining to the kidney

Retropharyngeal - situated or occurring behind the pharynx

Sarcoma - a tumor made up of a substance like the embryonic connective tissue

Splenomegaly - enlargement of the spleen

Spondylitis - inflammation of the vertebrae

Suppurative - producing pus

Supraclavicular - situated above the clavicle

Synovial - of or pertaining to or secreting synovia, which is a transparent alkaline viscid fluid resembling the white of an egg, secreted by the synovial membrane and contained in joint cavities, bursae, and tendon sheaths.

T-lymphocyte - type of white blood cell

Tendovaginitis - inflammation of a tendon and its sheath

Toxemia - a general intoxication due to the absorption of bacterial products (toxins) formed at a local source of infection

Urease - a test for urea based on the presence of an enzyme that catalyses the conversion of urea into ammonium carbonate

Ventricular - pertaining to a ventricle

Ventricle - a small cavity, such as one of the several cavities of the brain or one of the lower chambers of the heart

Source: DORLAND'S ILLUSTRATED
MEDICAL DICTIONARY
24th EDITION

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5.0 OPTIONS

5.1 Introduction

In the following sections, a number of practical solutions to the preceding problems are discussed, and one of a possible number of working models of each of these options is provided. Cost estimates are for basic comparison purposes only, and real costs may be much higher. When an appropriate course of action is chosen, more detailed analyses will be necessary to develop accurate estimates of the resources required.

The Task Force has not considered the many options resulting from combinations of the basic courses of action. Undoubtedly, other options will be proposed during public forums, and these should be examined carefully.

Information requirements are discussed in general terms for each option with no estimates of required resources. The Task Force did not identify any information gaps that prevented or inhibited analysis of any of the options at this initial level of consideration. The information gaps discussed for each option arise as requirements only if that particular option is chosen for further detailed analysis or as the desired course of action, and they would receive more specific attention at that time.

Regardless of which option is selected (with the exception of the Status Quo), the participating agencies will be required to develop cooperatively an interagency implementation strategy.

The options considered by the Task Force are summarized in Table 9.

Option 1, the Status Quo, maintains the present situation without additional management action by the park, but with acknowledgement that other agencies may be required to take independent action within their own jurisdictions.

Table 9: Options considered by the Bison Disease Task Force.

<u>Option #</u>	<u>Title Description</u>
1	Status Quo - no additional management action by CPS.
2	Wood Bison Recovery - salvage of wood bison genetic stock, elimination of diseased herd, and repopulation with disease-free wood bison.
3	Fencing - contain infected animals within WBNP area by double fencing the park perimeter.
4	Vaccination and Treatment - build corrals to systematically round up, vaccinate, test and release all bison, repeating as necessary.
5	Test and Slaughter - construct corrals and slaughter facilities; systematically round-up, tag, test all bison. Slaughter reactors. Process meat for human consumption where possible.
6	Buffer zone - contain diseases to WBNP by establishing a buffer zone at least 320 km wide around the park and maintain this zone clear of ruminants.
7	Fencing to Exclude Other Animals - prevent contact between livestock, other ungulates and bison by requiring ranches, game farms and other bison herds to be enclosed by double fences in the area from Great Slave Lake to High Level, then east to and south around WBNP.
8	Restrict Encroachment of Livestock and Wildlife. Through legislative changes, prohibit livestock and game farming in the area surrounding WBNP.
9	Composite Option - confine disease to the park by a combination of buffer zone, fencing and land use restrictions.

Option 2 involves the preservation of bison from WBNP and the SRL that are genetically indistinguishable from present wood bison stock, subsequent eradication of diseased hybrid bison, and repopulation of this area of traditional wood bison range with animals raised from the salvaged WBNP breeding stock, supplemented with wood bison from Elk Island National Park (EINP) and the Mackenzie Bison Sanctuary (MBS).

Under Option 3, Fencing, the infected bison population would be contained within the park by a double fence around the park perimeter. An ongoing maintenance and surveillance program would be required to ensure that the fence continued to prevent the escape of potentially diseased animals from the park area.

Option 4 consists of the vaccination and treatment of all bison through the use of round-ups and a corral system. A final round-up and testing of each individual animal would be required to confirm a clean herd.

Option 5, Test and Slaughter, also involves the use of round-ups and corrals for testing, but reactors would be slaughtered and the uninfected animals released. This would be repeated until a herd of negative status was obtained.

Options 4, 5, 6, 7 and 8, were not considered feasible. These are Vaccination and Treatment, Test and Slaughter, Buffer Zone, Cattle Fencing, and Restriction of Livestock/Wildlife Encroachment on the park.

Option #9 is a plan to confine infected animals (and therefore the diseases) to the park area by a combination of herd reduction, management action, and habitat manipulation. This plan would effectively create and maintain a bison-free area between the MBS and the park and between the park and agricultural land and domestic livestock to the south and west. Concurrently, research into the movements of the animals and population dynamics and controls would provide necessary basic knowledge on the herd as well as the means of assessing the effectiveness of the plan.

5.2 Option Discussion

5.2.1 Option #1 - Status Quo

5.2.1.1 Approach

At present approximately 4800 hybrid bison, descendants of the introduced plains bison and indigenous wood bison, roam over a large area in and near WBNP. It has been estimated that approximately 36% of these animals are infected with brucellosis, 36% are infected with tuberculosis, and about 50% of the herd have one or both diseases (S. Tessaro, pers. comm.).

Outlying herds associated with the park on a semi-permanent basis are found near the Firebag River north of Fort McMurray, near the Wabasca River to the west of Garden River, near Taerum and Buchanan Lakes inside the park south of Garden River, and to the northeast of the park between Hook Lake and the park boundary. Undoubtedly, animals wander in and out of the Park in numerous other remote areas where their movements are unrecorded.

The Status Quo option would not result in any specific or additional action by the participating agencies to diminish the diseases or their effects on bison within the park boundary.

Action may, however, be taken by agencies other than CPS to prevent spread of the diseases within their own jurisdictions.

5.2.1.2 Implications

Political

- a) **Local:** To date, the residents of the Fort Chipewyan area, Garden River and the two Indian Reserves west of that settlement have asked few questions about the present disease situation, perhaps through lack of

sufficient background information. The level of concern may increase if ranching is established in those areas.

In Fort Smith and Fort Resolution, concern has been expressed that presence of the diseases may hinder or prevent economic development in the area, principally the establishment of game farming in the SRL. This concern may increase as local organizations seek more economic opportunities.

The GNWT has expressed great concern that the diseases may be transmitted to the wood bison in the MBS. This would have serious repercussions for that rapidly expanding, disease-free herd.

Individuals in the Fort Vermilion area have expressed serious and continuing concern about the possibility of their livestock contracting either or both of these diseases. Alberta Agriculture is unlikely to curtail the encroachment of agriculture up to the park boundary, resulting in rising tension between the ranchers/farmers in the area and the park over possible disease transmission. Friction could result between the federal and provincial governments.

- b) **National:** Increased concern and political lobbying may be expected from the Cattlemen's Association and other groups or agencies with a direct interest in the livestock business. Livestock and product importing countries presently attempting to eliminate these diseases could react negatively if they became aware of the present situation and the potential for the spread of the diseases to livestock. Environmental groups are not presently actively concerned with the bison disease problem.

Agriculture - Animal Health

If this population of bison remains diseased, Agriculture Canada and Alberta Agriculture will have to maintain their disease surveillance and prevention programs both in the field and in packing plants at a considerable cost. There

would be a definite risk to expansion of the livestock industry in the region of concern to the Task Force.

Existing Bison Populations

The existing bison populations would remain diseased. The effects of these diseases on bison productivity have not been determined, although they probably contribute to generally lower productivity and higher effective predation by wolves. The bison population in the SRL continues to decline, but this is attributable to the fact that they are not protected and a substantial number are taken by native hunters every year.

The effect of the park's diseased bison on the general public is difficult to ascertain. There is little notice paid by either the local or visiting general public to the diseases or their effects. Few questions are asked and they are usually of a general nature.

The elimination of the diseases in WBNP would benefit the general bison population, but the overall effect on population numbers is difficult to predict as it is strongly suspected that other factors, including predation and changing range and ultimately forage quality, may be increasing mortality and decreasing productivity.

Wood Bison Recovery

The Wood Bison Recovery Program may be jeopardized by these diseased animals that inhabit the most productive areas of historic wood bison range. The MBS herd is definitely at risk and will certainly come into contact with infected animals soon if their present rate of expansion continues.

Alberta has decided not to release any of the captive wood bison presently in the Hay - Zama lakes area because of the potential risk of disease and genetic contamination.

Development

If the status quo prevails for the next several years, constraints will have to be put on agricultural expansion from the Fort Vermilion area toward the park, probably creating friction between the Province and livestock holders.

Any agricultural or game farming policies being developed by the GNWT would necessarily be influenced by the presence of the diseases in the park and surrounding area.

Legal and Policy

Until recently, Agriculture Canada has tacitly ignored this reservoir of disease in the park. However, now that the Canadian Cattle Herd is brucellosis-free and nearly TB-free and agriculture is moving closer to the park, they must recognize the potential for the spread of these reportable diseases. A single outbreak of tuberculosis or brucellosis in a regular domestic animal herd in the Fort Vermilion area or any other area near the park would not likely restrict the movement of animals in and out of the region except for the infected herd and its contacts. In this situation, Agriculture Canada would send inspection teams to check other herds. If this single infected herd were undetected for a number of years, it could result in the spread of disease to a large number of herds in many different areas. This would be much more significant and could compromise Alberta's, and possibly Canada's status as disease-free.

A more serious scenario would develop if an outbreak occurred in animals that were ranging on the Fort Vermilion grazing lease. In this case, none of the animals would be authorized to return to their ranches of origin. If animals were removed from the grazing lease and reactors subsequently discovered, then restrictions on cattle movements would be more widespread, possibly involving other provinces.

Other agencies may be required to make policy changes based on their perception of this option's effects. CPS would not likely require policy changes.

Public Health

Health and Welfare Canada has indicated that there is apparently little or no difference between numbers of reported cases of tuberculosis or brucellosis in the enzootic area and in other demographically similar areas in northern Canada. The risk would not increase with the status quo but neither would it diminish, especially among those people handling bison.

The fact that abattoir workers may refuse to slaughter animals from the enzootic area may be a cause for concern. Some unionized federal abattoirs will not accept brucellosis reactor animals.

5.2.13 Feasibility

Political

Politically, preservation of the status quo would eventually result in criticism from local to national levels for most agencies involved - either for not taking action on the existing disease problem or for curtailing certain development activities because of the disease problem.

Internationally, the presence of the disease problem and the perception that nothing was being done about it could cause some countries to bring sanctions against Canadian exports of livestock, meat, semen and dairy products. The USA, the major importer of our animal products, would be one of the leaders in this regard as they are striving to eradicate the diseases in their country.

The cattle lobby would likely become more militant and begin putting pressure on Agriculture Canada and Alberta Agriculture to do something about the presence of disease in the park. This could lead to interagency friction and possibly poorly thought-out, precipitous reactions to the increasing pressure.

Effectiveness

This scenario does not meet the objectives of the majority of the agencies. It does, however, meet part of the objective of CPS in that the heritage resource is preserved and a free-roaming herd of bison is maintained. The herd however would not be naturally regulated as the two diseases, which likely affect its productivity, were introduced by man through errors in early management of the bison and cattle.

Logistics

No action is required by CPS. Other agencies taking independent action as a result of preservation of the status quo will each have logistical requirements.

Time

The feasibility of this option decreases with time. As the MBS wood bison herd expands in size and range, increasing surveillance will be required to keep these bison separated from those in and around the park. It is estimated that these two populations of bison will make contact in three years given the present rate of expansion of the wood bison herd and the minimal surveillance. Increasing surveillance will be required around the southwestern portion of the park as agriculture moves closer.

Cost

The cost to Agriculture Canada of surveillance in northern Alberta will increase from the \$500,000 now spent annually in proportion to the rate of agricultural expansion in the area. Some agencies, particularly the GNWT and Alberta Forestry, Lands and Wildlife, may have to increase surveillance and take whatever other measures they feel necessary, all at additional cost.

5.2.1.4 Information Gaps

No additional information is required to evaluate the status quo option. The other participating agencies required to take action will have their own information requirements, particularly regarding the bison herds' seasonal movements and population dynamics in the area of concern.

5.2.2 Option #2 - Wood Bison Recovery and Disease Eradication

5.2.2.1 Approach

The plan would have the following five components.

- a) A reasonable effort will be made to identify and salvage bison that are indistinguishable from the wood bison phenotype from WBNP and the SRL. This requires first that an assessment be made of the importance of these genetic resources to the existing wood bison gene pool and to the long-term survival and viability of the subspecies. The taxonomic standard developed by Van Zyll de Jong (1986) would be used to confirm an individual animal's similarity to wood bison. This standard defines the characteristics of the wood bison phenotype and provides a key against which bison in the field can be compared.

This initial phase of Option #2 would test the hypothesis that bison in northern WBNP and Hook Lake were indistinguishable from wood bison. Bison still remain in northern WBNP in the area where capture operations conducted in 1963 and 1965 provided the initial stock for the Canadian Wood Bison Recovery Program. Some of these animals may closely resemble the wood bison phenotype. Since existing stocks of wood bison were derived from a very limited gene pool, 16 in the case of the MBS and 21 in the case of the EINP population, salvaging a larger number of animals from the WBNP and Hook Lake populations would broaden the genetic diversity of the wood bison subspecies.

An adequate number of bison would be collected from the areas in question, and possibly from other areas of WBNP, to compare skeletal and other characteristics with known wood bison specimens.

- b) Animals identified in the field as wood bison would be captured and tested for both tuberculosis and brucellosis; reactors would be destroyed.
- c) Double-fenced enclosures would be constructed to receive the disease-free wood bison and to hold them for a period while the rest of the plan was implemented. These wood bison would be joined by others from EINP and MBS, all of which had been tested and found to be disease-free, to form

the basis of a breeding herd which would ultimately repopulate the park ranges. If no disease-free wood bison were found in the initial phases of the operation, then the entire replacement herd would be comprised of animals from MBS and EINP.

- d) All other bison would be eliminated from the area of concern over a period of three to five years.
- e) When intensive surveillance indicated that all diseased animals had been eliminated and there was no risk of re-infection, the disease-free breeding herd would be released to repopulate the area. This may occur about 15 years after the start of the program, but the exact timing would depend on the specific details of the implementation plan and the resources available. It is expected that with a concentrated effort outside the park the danger to the livestock industry and the MBS herd would be much reduced within five years.

The preservation of bison from northern WBNP and Hook Lake in conjunction with elimination of bison populations infected with tuberculosis and brucellosis, would serve all of the agencies' objectives and would reaffirm the original purpose of WBNP, to protect the wood bison and its habitat.

5.2.2.2 Implications

Most of the following comments are predicated on the success of the wood bison salvage operation. It is anticipated that the positive aspects of this part of the option will to some extent balance potentially negative public reaction to elimination of the diseased population. If this initial phase of the option is not successful, the objections of public interest groups may be more intense or extreme than anticipated here.

Political

- a) **Native and Local Concerns:** The significant decline in bison numbers in the SRL and Hook Lake populations suggests that bison may eventually be extirpated from these areas under the current management regime. In

addition to the wildlife management concerns, declining bison numbers are of concern to residents of Fort Resolution and Fort Smith who currently hunt the animals. The recovery of wood bison stock and eventual repopulation of these areas should be seen by local and native groups as a positive alternative. However, after repopulation, hunting will be managed as long as wood bison are listed as an endangered species under the NWT Act. There are other members of the public who are not expected to support any program that involves replacement of bison in the park. Part of this resistance is related to the removal of the hybrid bison and part stems from the past negative experiences of the bison round-ups and depopulation efforts during anthrax control programs. The proposed wood bison ranch in the SRL represents an opportunity for native people to participate in a disease eradication and recovery program. It may be possible to negotiate an agreement with the appropriate native organizations to manage a semi-captive disease-free population as a breeding herd which could produce stock for release to the wild.

- b) **National:** There is considerable federal and provincial support for this option. The Canadian cattle industry should be satisfied. This action would be consistent with the original purpose of WBNP and with national efforts to re-establish the wood bison in its historic range.
- c) **International:** The international image of Canada with respect to the status of bovine brucellosis and tuberculosis would improve. The importance of WBNP bison as a national heritage resource would likely be enhanced because the stock would be recognized as disease-free wood bison rather than diseased hybrids. There would be international recognition of the conservation of genetic resources and the recovery of an endangered species at the core of its historic range.
- d) **Public Lobby Groups:** An initial strongly negative reaction can be expected from some animal welfare and environmentally oriented organizations concerned with the elimination of the existing herd. Opposition may diminish if the plan is demonstrated to be in the national interest and if

success can be assured. Other environmentalists may view the re-establishment of a healthy free-roaming of wood bison herd in its natural range as a permanent and desirable long-term solution to the current problem. The plan should remove pressure for unused bison range to be developed agriculturally. This option should return WBNP to its original purpose of preserving wood bison on their historic range.

Agriculture - Animal Health

This option should be supported by the agricultural community and ultimately would remove the threat of disease transmission to domestic livestock.

Existing Bison Populations

In general, the plan would be beneficial because it would eliminate the risk of disease and genetic contamination of other bison populations.

Developmental

This option could provide local and native entrepreneurs outside WBNP with an opportunity to participate in the recovery of wood bison through establishment of a bison ranch in the SRL. This could provide a source of breeding stock for wood bison re-establishment projects and contribute to long-term regional economic development.

This option supports agricultural and game farming development in northern Alberta and would eliminate the danger of disease transmission to cattle, domestic bison, game-farmed species, and free-roaming ungulates. Free-roaming species, particularly bison, could ultimately create a problem by grazing in cultivated fields.

Tourism

In the short term, Option #2 may have a negative effect on tourism as the bison population in WBNP declines. However, with public education about the problem being tackled and with advertising of the enclosed, viewable, endangered wood bison, the negative effect of eliminating the hybrid bison could be minimized. In the long term, a large viable population of wood bison should have a positive effect on tourism.

Wolf Population

In the short term during the bison depopulation phase, this option would be detrimental to the wolf population and would disrupt the established predator/prey relationship. A similar predator/prey relationship exists in the MBS and should develop after wood bison are re-established in the park and the surrounding area. Increased predation of other species, such as moose, could result in the interim. However, the long-term effects would be beneficial to predators as a larger more viable bison population would result.

Wood Bison Recovery

This option would broaden the genetic diversity of the wood bison gene pool. The historic epicentre of wood bison range would be repatriated, and wood bison populations could be reintroduced throughout much of the adjacent historic range. The CPS would enhance its role in preserving the genetic resources of wildlife in Canada.

Public Health

This option would eliminate the risk to the public of tuberculosis or brucellosis infection from hybrid bison.

Legal

There appear to be no legislative changes required.

5.2.2.3 Feasibility

Political

This option could be politically feasible if it is demonstrated to be in the national interest and accompanied by reasoned assurances of success. With cooperation from all agencies involved the likelihood of success is great. Further, it can be demonstrated that a large disease-free wood bison herd roaming freely on its former range is much more in the public interest than a diseased hybrid herd that threatens agriculture, wildlife, and human health.

Effectiveness

This option would be effective, but the speed of progress would depend on the funds allocated.

The feasibility of capturing bison from northern WBNP and eliminating disease was demonstrated in 1963 and 1965. Resources would dictate the number of animals that could be assembled and tested for disease. The proposed SRL bison ranch would provide a convenient infrastructure for establishing a disease-free breeding herd.

The most difficult part of this option would be establishing that all the diseased hybrid bison had been eliminated. This would require intensive aerial and ground surveillance over a large area for several years.

The rate of repopulation with wood bison would depend on the success of the salvage operation, the availability of stock from MBS and EINP, and the subsequent increase of the captive population.

Logistics and Time Frame

As previously stated, the logistics and time frame depend on the resources allocated.

- a) **Taxonomic Evaluation:** A taxonomic standard for the wood bison phenotype has been developed by Van Zyll de Jong (1986). During the initial operational phase, bison would be collected from populations that appear phenotypically representative of wood bison (Needle Lake and Hook Lake). Examination of these animals would be done to confirm taxonomic affiliation. If they were considered to be indistinguishable from wood bison, then a capture operation could be implemented. Capture methods would vary depending on the number of bison required.

The feasibility of eradicating tuberculosis and brucellosis with intensive testing, slaughter, and vaccination was demonstrated at EINP in the plains bison herd (brucellosis) and in the wood bison herd (both diseases). However the number of bison in a herd must be small; 100 or less is a reasonable size.

- b) **Depopulation:** The Depopulation Phase would take an estimated 5-15 years. The range occupied by the diseased bison population encompasses most liberally an area of 69,000 km², including WBNP, the Peace River drainage to just east of Fort Vermilion, the Firebag River, and the SRL. However, at least 90% of the bison are concentrated in about 13,000 km², an area only slightly larger than that presently occupied by the MBS population. About 70% of the WBNP bison population is found in the Peace River delta, which is no more than 3000 km².

Depopulation in the most densely occupied ranges could be carried out within three to five years, eliminating most of the reproductive segment of the population. Eliminating bison in the remaining area would take longer, since bison tend to occur in small scattered groups or as individuals. Depopulation in the low density areas may take another 10 years, in order

to guarantee that all bison are culled or die of natural causes (old age or predation).

The recommended procedure would be an intensive effort in the high density area during the winter. It would involve culling from helicopters and assembling dead bison at locations where they could be inspected and processed in mobile abattoirs. Federally inspected meat could be distributed to local communities or stored in freezers for future use. Slaughtering more than 1500 bison a year would involve marketing the meat beyond the local native population, which could be a source of discord. Careful consideration will have to be given to the meat distribution problem to avoid upsetting local economies. Extensive aerial reconnaissance during the late winter would be necessary to locate bison in the remote low density areas. Reconnaissance would have to be maintained over a 10-year period to ensure that all bison had been removed. It may not be feasible to recover meat from bison shot in remote areas. Since bison in these areas are mostly old bulls and the number of animals is small, meat wastage would be minimal. If sufficient resources were available, this method would allow about 1500 bison to be processed each year. The number of animals processed would depend on the resources available to transport bison to processing teams.

The annual rate of depopulation is expected to decline as bison density is reduced by culling and by dispersal induced by the culling operation. Bison are expected to learn to avoid areas where they are harassed by helicopters.

- c) **Herd Replacement:** The Herd Replacement Phase would begin immediately. Two double-fenced enclosures 10 km X 10 km would be constructed while hybrid bison were being eliminated from the immediate area. This phase has three possible scenarios depending on the success of the genetic salvage program. If the program is completely successful, rescued wood bison stock from WBNP would form a new disease-free herd supplemented by stock from EINP and MBS, and the enclosures could be used immediately for disease

testing and treatment and subsequently to enclose the captive breeding herd until release.

If stock is not obtained from WBNP, the MBS and EINP would be the sources of bison for repopulation, supplied at an annual rate of 90 and 30 animals, respectively. Supplied over a 10-year period and augmented by animals from other captive breeding herds, this imported population could reach 11,000 after 15 years (C. Gates, pers. comm.) or more if replacement animals are selected for repopulation (more females than males). The proportions from each source would determine the logistics and rate of repopulation. The bison from EINP could be captured and transported easily. However, corrals would have to be built in the MBS and special teams sent in for capture and transportation of animals to WBNP.

Assuming the procedure recommended here is followed, depopulation in 5 years would allow up to 10 years for surveillance to ensure the last isolated hybrid animals have been removed. This long surveillance time is the program's best guarantee of success. Stray animals would be found in decreasing numbers for about five years, then five years of no bison sightings would indicate that release of the enclosed wood bison could begin.

Regardless of the repopulation scenario adopted, enclosure of a large herd requires intensive management, and estimated costs would have to include the costs of feeding bison once the carrying capacity of the corrals was surpassed. Carrying capacity of each of the two enclosures has been estimated at 700 animals (H. Reynolds, pers. comm.). Thus after 1500 bison have been enclosed, feeding would be required. With totally imported animals, this point would not be reached until year 7. Feeding costs could be substantial, and consideration may be given to raising replacement stock in other localities, increasing the number of corrals, rotating pastures or keeping fewer animals.

Costs

Some of the costs associated with Option #2 have been estimated, and an itemized and annotated list is contained in Appendix II. These figures are for comparison and discussion purposes only. Comprehensive costing requires a detailed implementation plan, and that can only be developed when an option is finally chosen.

The following is a summary of these estimated costs. A detailed explanation of the estimates is found in Appendix II.

a)	Taxonomic Evaluation: Costs of the genetic salvage program have not estimated.	
b)	Depopulation (over 3 yrs.):	\$2,389,000
c)	Post depopulation surveillance and field slaughter (over 10 yrs.):	747,000
d)	Repopulation (over 15 yrs.):	<u>4,135,000</u>
	TOTAL	\$7,271,000

The costs of feeding replacement stock are also estimated in Appendix II.

5.2.2.4 Information Gaps

Implementation of Option #2 will require information on many topics, including the following.

1. Regarding the taxonomic evaluation of bison, it will be necessary to:
 - determine how much time can be allowed for this phase;
 - determine how many animals are required for study to confirm similarity to the wood bison phenotype;
 - determine the optimum number of animals required to conserve genetic diversity;
 - determine what areas are likely to contain the desired animals.

If it is verified that there are wood bison in the area, it will be necessary to determine:

- how many animals are going to be retrieved and how does this number relate to the final number expected to remain after disease testing and slaughter of reactors;
- will the animals come from one area or from several different areas;
- how many test and slaughter corrals will there be and where will they be located; and
- how many enclosures for negative reactors and breeding enclosures will there be and where will they be located.

2. Regarding the removal of diseased animals:

- documentation of the extent of hybrid bison range;
- determination of the longevity of bison bulls. These single bulls will be the most difficult to locate and eliminate. An assessment of their life expectancy will give the agencies involved some approximation of the period over which hunting and surveillance will have to continue;
- determination of some means of verifying that all hybrid bison have been eliminated;
- determination of the significance of other species, such as wolves and moose, as vectors of brucellosis. Studies in this regard are currently underway (Tessaro, pers. comm.);
- removal of the existing bison herd may be perceived to have a negative impact on tourism in the WBNP area. The agencies involved should be prepared to address the question of compensation for local businesses;
- native people and Alberta residents are currently allowed to hunt bison outside WBNP. The agencies involved should be prepared to address the question of compensation for loss of food and recreational opportunity; and
- assessment will be required of the impact of removal of bison on predators, specifically wolves, and possible impacts on other prey species such as moose and deer.

3. Regarding the Replacement Phase, the following must be determined:

- location of holding areas and desired stocking rate.
- will feeding of captive bison be undertaken.

In addition, an interagency operational plan for implementation of the option will be required.

5.2.3 Option #3 - Fencing the Perimeter of WBNP

5.2.2.1 Approach

Fencing WBNP would contain the infected bison population within the boundaries of the park and thereby prevent transmission and spread of disease to domestic livestock and other wildlife in adjacent areas. A double fence will be required to guard against potential escapes through breaks in the fence. An inspection program will also be necessary once the fence is constructed to monitor for breaks and to determine maintenance requirements. This option necessitates the removal of diseased bison from all areas adjacent to the park. This action would be the responsibility of other participating agencies and would be conducted within an interagency implementation plan.

The perimeter boundary of WBNP is about 1160 km in length. Prior to construction, a right-of-way approximately 10 m wide would be cleared within which the fence and an access road for construction and maintenance would be built.

The fence inspection program would require at least once-a-month surveillance to monitor for breaks in either of the two fences and to assess effectiveness. The access road should be usable year-round to permit maintenance activities. Without ground access, it would be necessary to conduct inspections and to do maintenance using helicopters at increased costs.

5.2.3.2 Implications

Political

It is believed that the local trappers association would adamantly oppose any proposal to fence the boundary of WBNP. If a fence option were chosen, it would be necessary to install access gates or entry points at 5-10 km intervals to facilitate movement of trappers across park boundaries. This would add significantly to the cost of construction and would greatly inconvenience those trappers requiring access to the park. The risk of illegal entrance between specified

access points would be high and would probably necessitate increased surveillance during the trapping season.

The cattle producers lobby, concerned with the possible spread of disease from infected bison to domestic cattle herds, would likely be satisfied with the completion of a fence to contain bison within the park. An effective fence barrier would tend to ease international concerns regarding Canada's beef exports. It would also maintain Canada's brucellosis-free status as long as the fence proved to be an effective barrier to the movement of bison. However, the risk would always be present that one bison escaping through the fence would jeopardize the disease-free status and international trade markets.

It is not known how environmental groups would view fencing of the park under these circumstances or what impact fencing may have on the designation of WBNP as a World Heritage Site. In addition, the potential for environmental impact from fence construction would have to be assessed through the Environmental Assessment and Review Process (EARP) and would likely involve public hearings. The impact of the fence on other wildlife, such as moose, woodland caribou and wolves, other than restricting movements across park boundaries, is not known. Moose could damage fences when trying to jump over.

The ultimate effectiveness of a fence around the park depends almost entirely on the removal of all diseased bison outside the enclosed area. Alberta Forestry Lands and Wildlife Department and the NWT Wildlife Service would be the agencies responsible for this aspect of the plan, and the logistics and funding will be a call on their resources. As this cooperation is critical to the plan, these responsibilities would be set out in the interagency implementation plan.

Animal Health

An effective fence barrier would remove the threat of disease transfer from park bison to livestock in surrounding areas.

Existing Bison and Other Wildlife

A boundary fence would have little or no effect on the existing populations of bison in the park other than restricting outward movement of animals from the park. Control of bison movements across the park boundary would be viewed in a positive manner in terms of preventing the spread of disease. A fence would likely affect the movements of moose and woodland caribou; the latter move considerable distances, sometimes across the park. The movements of wolves in and out of the park would also be restricted, but not to the same degree, as these animals would likely find or create their own access points under the wire. The full extent of the impacts of a fence on these species and others is not known.

Wood Bison Recovery

An effective fence barrier along the boundary of WBNP to contain diseased hybrid bison would permit the Wood Bison Recovery program to proceed in adjacent regions. However, if successful recovery of wood bison is to occur, a clean-up removal program of all potentially diseased bison inhabiting bordering areas is required in conjunction with construction of the fence. Then, introductions of wood bison would be possible in the SRL, in the southern Mackenzie region, and in most areas of northern Alberta.

Legal

It is not known what effect the fencing option might have on native land claims issues, specifically unsettled claims to areas within the park. Access points and hunting rights to areas that may be removed from park control would be a major issue of concern to native people in negotiation of their claims. In addition, construction of a fence may have legal implications with respect to access rights for resident trappers who trap in the park. Fencing of rivers, such as the Peace, will require approvals from Transport Canada under the Navigable Waters Act.

Agricultural Development

An effective fence barrier to contain diseased bison within WBNP would allow unhindered expansion of agriculture in the Jean d'Or Prairie and Fort Vermilion areas in northeastern Alberta. Development of this region for agricultural production of beef cattle and swine could continue with possible northern expansion into areas adjacent to the park. Removal of all bison in areas adjacent to the park would be required after the park fence is constructed and prior to expansion of agricultural development.

Public Health

Bison now hunted in the area are mostly WBNP animals that cross the park boundary and cease to be protected. Use of these potentially diseased animals is a public health concern. This option would alleviate those concerns once the WBNP herd was contained within the park and no longer available for hunting.

5.2.3.3 Feasibility

Political

The fencing option would require an agreement with Alberta and the NWT to remove all diseased bison from lands over which they have jurisdiction adjacent to the park. This option is only feasible and effective if the cooperation of these other agencies is obtained. Both Alberta and NWT would have to deal with considerable public concern and political "fall-out" over their participation in this program.

Time Frame

It is estimated that construction of a boundary fence for WBNP will take at least three years, and the removal program on adjacent lands may require an additional two or more years. This is considered to be a relatively short time in view of

the benefits of preventing disease transmission to domestic livestock and the freedom to proceed with the recovery of wood bison in areas of historic range.

Logistics

Technical and logistical problems caused by difficult terrain conditions will greatly increase estimated construction and operational costs and could seriously affect the overall feasibility of the fencing option. The most important problem will be fencing the Peace River at two locations, on the west boundary and on the east side of the park. There are also six other rivers, four creeks, and four lakes to be crossed, for a total of 19 km of fence construction across water.

Other difficulties will be encountered with the construction of a fence through two mountain ranges - 100 km through the Birch Mountains along the south boundary and about 125 km in the Caribou Mountains along the west boundary. The additional costs for fencing these 225 km of mountainous terrain are not known.

Difficulties will also be encountered along the entire east side of the park (approximately 540 km) where the boundary is irregular and follows river banks and where numerous creeks and wet low-lying drainage areas must be crossed. Muskeg is present in most of the wet areas along the east side, as well as many areas along the other boundaries and can only be fenced during the winter when the ground is frozen. The additional cost required to deal with these problems is not known.

The maintenance requirements for a fence constructed in muskeg will be considerable, and the fence will likely require major repairs during spring thaw each year. Access for boundary patrols will be extremely difficult at this time of year and may have to be done using aircraft. Surveillance activities will have to be intensified during spring breakup when the potential for fence damage from frost heaving is greatest and when maintenance is most difficult. Also, access points for trappers will have to be installed along the boundary fence during the

construction phase. These logistical problems for construction and maintenance will add significantly to capital as well as to operations and maintenance costs.

In addition to normal repairs, a major post replacement project will be necessary every 30 years, the maximum time that treated posts can be expected to last. In wet areas and muskeg, posts may last only 20 years before replacement is required.

The potential of fire damage to the fence should be considered when choosing fencing materials. In view of the disastrous consequences of loss of containment over a significant length of park perimeter, fireproof posts may be required in some areas.

Effectiveness

The effectiveness of a fence to contain diseased bison within the boundaries of WBNP depends entirely on the success of a surveillance and maintenance program to detect and correct any problems. An adequate fence that is properly maintained will be effective in confining diseased bison to the park. The double fence is necessary so that a break in the first fence can be found and repaired before animals escape through any break in the second fence. Even with a double fence, there will always be a risk that breaks could occur in both fences. If that happens and diseased bison escape, the original purpose of the fence is defeated. Also, the overall effectiveness of the fence is dependent on a successful program to remove all bison in areas adjacent to the park. If one diseased bison remains in the removal area or if one escapes from the park through the fence, then this option is no longer effective.

Cost

Based on an estimate of 21.7 person days to construct 1 km of fence (7 person crew, 5 days for 1 mile) and assuming a similar labour requirement for fence line brushing, it would require approximately 96 person-years (PYs) to clear a fence line and build an access road around the boundary of the park. Using the same

labour estimate, approximately 192 PYs would be required to construct a double fence around the park perimeter (1160 km x 2). Therefore, the total workforce required to clear the fence line boundary and to construct a double fence would be approximately 288 PYS.

Based on estimated costs for fence line brushing in Manitoba, a cost of \$1500/km (including equipment and labour) is proposed. Therefore fence line clearing for the boundary of the park would cost an estimated \$1,740,000 (\$1500 x 1160 km). Based on estimated costs for construction of a 7-foot page wire (9 gauge 6 x 6 mesh) fence at EINP in 1981, a cost of \$10,000/km (including materials and labour) is proposed. Therefore, the estimated cost to construct a single fence along the entire boundary of WBNP would be \$11,600,000 and the cost for a double fence would be \$23,200,000. The total capital expenditure to complete the fence line brushing and fence construction for the entire boundary of the park is estimated at \$24,940,000. Also, a 10% additional cost for work in the north and to compensate for the difficulties expected in a limited access region should be included, plus an unspecified amount for work in adverse terrain such as muskeg. Expenses would be increased by \$2,494,000 for a total estimated cost of \$27,434,000. A regular monitoring and maintenance program is estimated to require an additional 2 PYs and \$70,000 a year under operations and maintenance.

Within 30 years of the initial construction, a major fence post replacement program will be necessary and will require a capital expenditure of approximately \$11.6 million.

Annual maintenance costs will be in part a function of the materials and techniques chosen for initial construction of the fence, particularly in areas of difficult terrain, such as muskeg. More costly materials may reduce the requirements for annual repair and may lengthen the time before replacement. The implications of fence failure are so significant that additional expenditures to cope with these problems and natural hazards, such as the use of fireproof fence posts to protect the fence in the case of forest fire, should be considered.

The removal of bison from lands adjacent to the park is absolutely essential if the fence option is to be effective. This process has not been costed here, but as this aspect of the plan is an integral part of Option #2 as well, general estimates of costs and resource requirements can be obtained from the detailed discussion in Appendix II.

5.2.3.4 Information Gaps

Many of the information requirements discussed under the Depopulation Phase of Option #2 (section 5.2.2.4) apply to Option #3 as well. These include information required to locate, eliminate and verify removal of all diseased bison from the areas adjacent to the park and possible requirements for compensation of hunters who use these animals outside the park.

Fencing of WBNP would require information on the following:

- assessment of the impact of the fence on other wildlife populations, predator-prey relationships, etc.;
- consideration of the desirability of creating an 'island park';
- the impact of a fence on local land use and land claims issues;
- compensation for hunters and trappers who previously used the park area and/or crossed it without hindrance;
- location of gates for access to and from the park, and in this regard, the need for an intensive public information program to make local people aware of the importance of the fence and the need to maintain it intact; and
- detailed information on construction techniques, costs, and reliability of materials for difficult construction areas.

5.2.4 Option # 4 - Vaccination and Treatment

5.2.4.1 Approach

Following construction of a series of corrals, all bison would be systematically rounded up, corralled and put through chutes where each would be identified with eartags, treated and/or vaccinated, and released. This procedure would be repeated as required. After an initial period, untagged animals (i.e. animals that had never been captured) would be eliminated by active hunting teams. When the herd was believed to be free of disease, all animals would be rounded-up and each tested for tuberculosis and brucellosis.

5.2.4.2 Implications

Political

- a) **Native and Local Concerns:** There would be little change in the present situation until these diseases were eliminated, then a more productive herd could provide more hunting opportunities outside the park. It would be necessary to ensure that animals under drug treatment were not hunted and consumed.
- b) **National:** If successful, this option would remove the disease-related problems. It would remove anxiety from the national agricultural industry and increase the viability of the hybrid bison.
- c) **International:** The treatment option would ultimately improve this national heritage resource and would maintain the WBNP herd as the largest free-roaming bison herd in the world.
- d) **Public Lobby Groups:** These groups would likely approve of treating the bison for disease, rather than eliminating them. They may react negatively to bison deaths during the corralling process.

Agriculture - Animal Health

If these two diseases are eliminated, the danger of disease transmission to livestock in the area of concern is also eliminated.

Existing Bison Populations (WBNP & SRL)

Existing bison populations would be maintained and should become more viable as diseases are eliminated. There would be losses due to repeated handling.

Development

Under this option, once the wild bison herd was disease-free, the disease-related impediments to further agricultural and game farming development in areas near the park would be removed. However, if wood or plains bison were raised on game farms in the area, the risk of genetic contamination would still remain.

Tourism

Tourism would be enhanced as the bison herd became healthier and ultimately more productive.

Agriculture Industry

Implementation of this option would be evidence nationally and internationally that action was being taken to deal with the disease problem. However, the actual danger of disease transmission and international skepticism regarding Canada's disease-free status would persist until the diseases were completely eliminated.

Wolf Population

Implementation of this option would not affect wolf populations in the short term. Ultimately, increasing bison numbers would be a positive influence on wolf populations.

Wood Bison Recovery

- a) **Disease:** A successful treatment program would ultimately eliminate the disease threat to wood bison.
- b) **Genetics:** This option does not address the problem of genetic contamination of wood bison populations in the area of concern. The threat of hybridization would remain and probably increase as the hybrid herd became more productive.

Public Health

When the treatment program is completed and the diseases have been eliminated, the danger to public health will also have been eliminated. However, during treatment the danger to hunters and consumers of diseased bison will still exist and will be compounded by the presence of drug residues in the meat.

5.2.4.3 Feasibility

Logistics

The entire hybrid diseased bison herd both in and outside WBNP would have to be caught and treated repeatedly. The operational difficulties of doing this are enormous, and to be effective, every animal must be captured every year for treatment. Treatment for tuberculosis is continuous; if treatment is stopped, relapses occur. Every year, all newborns would require treatment and vaccination.

Effectiveness

There is no reliable treatment for brucellosis or tuberculosis in livestock. Because B. abortus and M. bovis are intracellular pathogens, most antibiotics cannot reach them in sufficient concentration to eliminate the infection. Liposome delivery systems have not improved the efficacy of antibiotics for the treatment of brucellosis in cattle. Few drugs can effectively penetrate chronic lesions of tuberculosis. Antibiotic therapy for brucellosis in people is not entirely reliable, but, fortunately, infected people do not transmit the disease. The treatment of human tuberculosis requires the use of expensive tuberculostatic and tuberculocidal drugs for a long period. These drugs have not proven to be reliable for use in animals, and the cost and lengthy maintenance of therapy is not tenable for use in livestock.

Vaccines have been evaluated for the prevention and control of bovine tuberculosis and brucellosis. Decades of international research have shown that Bacille Calmette Guerin (BCG) vaccine is not effective for the prevention or control of tuberculosis in livestock. No other vaccine is available for use against tuberculosis in animals. BCG vaccination of calves for tuberculosis must take place as soon after birth as possible and calves do not achieve immunity for six weeks. The immunity is not strong and vaccinated animals must not be exposed to severe infection.

Of several brucellosis vaccines that have been studied in cattle, only Strain 19 vaccine has been widely used. In cattle herds, Strain 19 does not provide complete protection from the disease but has been used to reduce the incidence of brucellosis to more manageable levels. It does not completely eliminate the risk of spread of virulent field strains of B. abortus. Once implemented, a Strain 19 vaccination program must be maintained indefinitely or else the disease will re-emerge. Use of the vaccine complicates the serological diagnosis of bovine brucellosis and therefore masks the true prevalence of the disease. Preliminary studies in the USA indicate that Strain 19 vaccine will cause abortion in bison.

Thus, apart from the difficulties of corralling the herd, treatment and vaccination would fail to eliminate either disease. As well, this option would not remove the threat of genetic contamination of wood bison.

Political Feasibility

Previous attempts at disease control in WBNP failed due to high cost, treatment ineffectiveness and negative public reaction to repeated corralling and handling of bison with questionable benefits. Many of these same arguments would arise again.

In the short term, this option has few negative political implications as the bison herd remains intact and aggressive programs are underway to control the diseases. The ultimate effect, however, would be extremely negative when, after years of costly, intrusive treatment, the diseases still exist within the herd and none of the potential benefits of the option have been realized.

Time Frame

With current vaccines, treatments and procedures, this program would never be successful.

Cost

a) Initial Capital Outlay:

Capital costs would include:

- the construction of a corral system of sufficient size to capture, hold, treat and test all hybrid bison;
- surveillance flights to establish where such construction should occur;
- the cost of drugs, brucellosis vaccine (\$1/dose), BCG vaccine (TB), isoniazid (\$20/yr/animal 1970), and oxytetracycline (10g/animal). Costs have not been calculated specifically as the section on effectiveness shows this option would fail.

b) **Operational Costs** - would include:

- the hiring, feeding, housing and transporting of corralling and treatment crews;
- helicopter time for herding and surveillance;
- the hiring, feeding, housing and transporting of hunting crews to eliminate all bison not corralled and treated.

5.2.5 Option # 5 - Test and Slaughter

5.2.5.1 Approach

A series of corrals and slaughter plants would be constructed. All bison would be systematically rounded up, corralled and put through chutes where each would be identified with ear tags and back tags, a blood sample collected and tuberculin injected into the caudal fold. The bison would be held for 72 hours during which time blood samples would be tested for brucellosis. After test results had been obtained, the bison would be run through the chutes again, and tuberculosis and brucellosis reactors removed and penned separately.

The animals that test negatively could be released or held temporarily in large corrals for future retesting if false negatives are suspected. Positive reactors would be slaughtered and processed through the federal inspection system, and where possible, meat provided for human consumption.

This process of repeated testing would be continued until a herd of negative status was obtained. After an initial period, animals which were not tagged would be eliminated by hunting teams.

5.2.5.2 Implications

Political

- a) **Native and Local Concerns:** During the test and slaughter program, consideration would be given to the local distribution of meat declared fit for consumption. After tuberculosis and brucellosis were eliminated, herd productivity should increase as would hunting opportunities outside the park.
- b) **National:** If this program were successful, it would remove the major disease-related problems. It would remove the anxiety from the national agricultural industry, and increase the viability of the hybrid bison herds.

- c) **International:** This program would ultimately improve this national heritage resource. However, while the slaughters were ongoing, there would be negative pressure from concerned groups. With these diseases removed, Canada's international agricultural trade status would improve.
- d) **Public Lobby Groups:** Public lobby and environmental groups may react negatively to the slaughter of bison and the losses of bison during handling procedures. Previous disease control programs have been abandoned in part because of negative public reaction to excessive handling of the animals and also because of ineffectiveness in solving the disease problem.

Agriculture

Elimination of these diseases removes most agricultural concerns about disease transmission to livestock, export certification, and expansion of agriculture and game farming in the area of concern. While underway, the program provides evidence nationally and internationally that the disease problem is being tackled aggressively. The most beneficial results of the program, however, only accrue when the diseases are completely and successfully eradicated from the bison herds. The option does not eliminate the problem of hybridization with domestic (game farmed) bison or with free-roaming wood bison in other areas of reintroduction.

Existing Bison Populations (WBNP & SRL)

A large percentage of the existing bison herds would be lost due to positive test reactions and slaughter.

Tourism

The herd would still exist, but numbers would be greatly reduced until the diseases were eliminated. In the short term, this would be detrimental to tourism, but the industry would undoubtedly recover once a viable disease-free herd was re-established.

Wolf Population

The reduction in the bison herds may have negative effect on wolf populations, but ultimately this option could produce healthier, more viable bison populations and a stronger predator population as well.

Wood Bison Recovery

- a) **Disease:** A successful test and slaughter program would ultimately eliminate the disease threat to wood bison; this threat would remain however until the test and slaughter program was successfully completed and the herd was disease-free.
- b) **Genetics:** This option does not address the problem of genetic contamination of wood bison populations in the area of concern. The threat of hybridization would remain and probably increase as the hybrid herd increased and became more productive.

Public Health

When the test and slaughter program was completed the danger to public health would be removed.

5.2.5.3 Feasibility

Logistics

The entire diseased hybrid herd in and outside WBNP would have to be caught repeatedly and held pending reading of results and culling of reactors. All reactors would have to be removed.

Effectiveness

This option would not remove the threat of genetic contamination of wood bison.

The test and slaughter option can be effective only if all animals can be caught repeatedly. A similar plan succeeded in eradicating brucellosis in captive plains bison at EINP by an initial drastic reduction of the herd from 2200 to 400 and a program of calf vaccination. Tuberculosis and brucellosis in captive wood bison at EINP were eradicated only by bottle feeding calves and eliminating the entire original population.

As described in Chapter 2, attempts to round up the entire WBNP herd for anthrax vaccinations were unsuccessful. At best, only a third of the herd was captured, losses due to handling were high, and in those programs, the animals did not have to be held or handled twice for the reading of tests.

With allowance for false negatives, it would take many years of complete herd testing to eliminate these diseases, and even then total eradication may not be possible. This option would be ineffective as it is virtually impossible to capture this entire wild population once, not to mention repeatedly.

Political Feasibility

This option is particularly unattractive politically. Its chances of success are minimal, it combines round-ups and slaughters which have provoked strongly negative public reaction in the past, it does not remove the threat of genetic contamination of wood bison, nor does it return wood bison to WBNP. Agricultural concerns remain unresolved until the program has been declared completely successful and, as success lies in the repeated capture of the entire diseased hybrid herd, this is unlikely ever to happen.

Time Frame

The time frame would be very long, too long to satisfy the objectives of the participating agencies. Wood bison would be expanding into this territory before the diseases were eradicated. It would, however, be possible to speed the process by eliminating all the adult bison at the beginning.

Cost

a) Initial Capital Outlay

Initial capital costs would include:

- the construction of a corral system of sufficient size to capture, hold, and test all hybrid bison;
- the construction of slaughter facilities to federal standards; and
- reconnaissance flights to establish where such construction should occur. Costs have not been calculated specifically as the section on effectiveness shows this option would fail.

b) Operational Costs

Ongoing operational costs would include:

- the hiring, feeding, housing and transporting of corralling crews;
- helicopter time for herding and surveillance;
- the hiring, feeding, housing, and transporting of slaughter crews.
- facilities for meat storage and distribution; and
- the hiring, feeding, housing and transporting of hunting crews to eliminate all bison not corralled and tested.

5.2.6 Option # 6 - Buffer Zone

5.2.6.1 Approach

A buffer zone approximately 320 km wide would be created around WBNP. Within the buffer zone, all bison and cattle would be eliminated and the raising of livestock would not be allowed. Surveillance and regular patrols would be required to ensure that hybrid bison from WBNP did not cross the buffer zone.

5.2.6.2 Implications

Establishment of a buffer zone would likely result in significant negative reaction from local groups, livestock producers and the general public because of the exclusion of livestock and bison from the zone.

If a buffer zone were effective, this option would remove most of the potential national and international problems. The present agricultural and animal health concerns would be satisfied and the cattle lobby would be appeased. International trade in livestock would not be affected. The existing bison herd in WBNP would be maintained in its present state and the threat of genetic and disease contamination of cattle and bison herds outside of the buffer zone would be removed. The large area required for the buffer zone would restrict future range extension by the MBS wood bison population. There would continue to be a risk to the health of persons in contact with bison from WBNP.

5.2.6.3 Feasibility

The tendency of bison to migrate would necessitate such a large area for a buffer zone that it would not be feasible. A zone of at least 320 km surrounding WBNP would be required to effectively isolate the bison. This would extend generally south to Slave Lake, west to Hay Lake and north to Great Slave Lake. Effectively, no susceptible animals would be allowed in this very large area, and all cattle and bison north of Manning, Alberta would have to be removed. The buffer zone

would have to be maintained in the future as long as the threat of disease and genetic contamination remained.

It would be impossible to maintain effective surveillance of this extensive area to prevent animal movements out of the zone. If only a single bison crossed the buffer, the possibility of genetic contamination and the spread of brucellosis and tuberculosis would recur.

Agriculture is well established in the Fort Vermilion area, and livestock and cattle production is essential to farm viability. There is currently no legislation that would facilitate the removal of livestock and wildlife from the designated area, and governments would be unlikely to consider any enabling legislation because of negative reaction from the agricultural lobby.

The Task Force agreed that a buffer zone would not be a feasible option in the longer term. However, a limited buffer zone will have to be considered in the near future to protect the rapidly expanding wood bison herd in the MBS.

5.2.7 Option # 7 - Fencing Cattle and Other Ungulate Populations

5.2.7.1 Approach

Construction of suitable fencing to exclude livestock and wildlife such as bison, moose, elk and deer from contact with the hybrid diseased bison in WBNP has been proposed as an alternative to fencing WBNP. Conceptually, this consists of construction of a barrier or exclusion fence from Hay River along the Mackenzie Highway south to the 29th base line near Hutch Lake, then east to the park boundary, turning south along the western park boundary to the 25th base line. This represents a distance of about 450 km. As identified in the fencing option, double fence would be required, as well as access roads for construction, maintenance, and regular monitoring and maintenance. All bison on the agricultural side of the fence would be removed.

5.2.7.2 Implications

It is suggested that this option would remove the threat of spread of brucellosis and tuberculosis from WBNP and would permit the Wood Bison Recovery Program to proceed in the adjacent areas to the west. Following the route proposed, there would not likely be any significant legal obstacles to the construction if the NWT and Alberta governments agreed with the concept. Access gates or crossing points would be required to facilitate some movement across the barrier. Agricultural development and expansion in the Fort Vermilion area would not be impeded and the concerns of Canadian cattlemen would be addressed as long as the integrity of the fence was maintained. There is some indication that a few free-ranging bison exist outside WBNP near the southwest corner of the park. These animals would have to be removed to establish a disease-free zone west of the park.

The Wood Bison Recovery Program in northwestern Alberta and the southern Mackenzie region could proceed, but wood bison would be excluded from a large portion of their former range. Bison in the area between Great Slave Lake and WBNP and the SRL would be vulnerable to hybridization and the spread of

diseases. This may interfere with the establishment of a bison ranch in the SRL and may be viewed negatively by those urging increased bison numbers in the SRL. Public health concerns about brucellosis and tuberculosis in bison in WBNP and the SRL would not be addressed.

5.2.7.3 Feasibility

The agreement of Alberta and the NWT would be required to facilitate construction of the barrier fence. The appropriate legal authorities would have to be researched. It is estimated a fence could be constructed within two years and would address the concerns of several agencies. The technical and logistical problems associated with construction would be similar to those discussed for Option #3, though not as severe. The major problem may be constructing an adequate fence across the Peace River. Regular access for surveillance and maintenance would be simpler, and the difficulties of public access would also be reduced. A safe end point for the fence would have to be determined.

Regular surveillance to maintain the integrity of the fence would be required. A major replacement program would be required about 20 years after construction is completed. Forest fires will continue to be a major problem in maintaining an effective barrier. The fence may interfere with traplines and the movements of other wildlife.

The effectiveness of this option in maintaining complete separation of free-ranging wood bison and cattle from diseased bison depends upon maintenance of the integrity of the fence. Even with a regular surveillance and maintenance program, there will always be some risk of a break in the barrier. The escape of any diseased bison would mean failure of this option.

A cost estimate for this option can be made using the assumptions developed for fencing the entire perimeter of WBNP (Option #3). Costs of fence line clearing for a double fence would amount to \$1,380,000 if the entire distance required brushing. Some costs can be reduced by following the Mackenzie Highway for part of the distance. Construction of a double seven-foot page wire fence would

cost \$9,200,000. A 10% allowance for increased costs for work in the north would add an additional \$1,058,000. The total estimated costs of construction of a suitable exclusion fence would be \$11,638,000.

Additional costs for annual surveillance and maintenance would have to be determined. A major replacement program would be necessary in 20 to 30 years. The estimate does not include the cost of removal of diseased hybrid bison from the area west of the WBNP.

5.2.8 Option # 8 - Restrict Encroachment of Livestock/Wildlife on WBNP

5.2.8.1 Approach

Option #8 proposes restricting the encroachment of livestock and wildlife on WBNP. Since wildlife can only be restricted by a physical barrier, such as a fence, this limits the option to livestock and captive game-ranched wildlife. It requires that no livestock or captive ungulates be raised on private and crown lands within a specified distance of WBNP. A buffer zone of 320 km was identified in Option #6 as the distance necessary to effectively isolate the bison in WBNP and prevent the spread of disease.

5.2.8.2 Implications

This option would require removal and future exclusion of all cattle and captive ungulates from the area north of Manning, Alberta. Agriculture is well established in this area, and cattle and domestic bison are already being raised within 100 km of WBNP. The province of Alberta has made a massive investment in the infrastructure required to support agricultural development in the north Peace region. In this regard, many of the points discussed for Option #6 also apply to Option #8.

The movements of wildlife and free-ranging wood bison toward the park would not be prevented without the addition of an exclusion fence.

5.2.8.3 Feasibility

The political will to enact legislation to facilitate the removal of livestock and captive ungulates from this area would not be readily forthcoming. Livestock producers and agricultural interests would be expected to respond very negatively to a ban on raising livestock in the area unless an adequate compensation program was implemented and payments maintained each year.

The public health concerns over the presence of brucellosis and tuberculosis in bison in WBNP are not addressed by this option. The Wood Bison Recovery Program would be severely compromised and the concerns of the GNWT about disease and genetic contamination of the MBS herd would remain. Therefore, the Task Force agreed that this option was not a feasible alternative to address the concerns of the various agencies.

5.2.9 Option # 9 - Confine Diseases to WBNP (Composite Option)

5.2.9.1 Approach

Option #9 combines elements from several other options in an attempt to confine potentially infected bison (and thus tuberculosis and brucellosis) to WBNP. This option would test the capability of various government agencies to implement a joint coordinated disease control program and would provide time for required research into bison movements and disease transmission.

This program would involve the following components:

I Population Control

- a) no bison would be tolerated west of the park boundary on Alberta land or north of the park between the park boundary and the Mackenzie River;
- b) both hybrid and wood bison would have no protected status whatsoever in these areas;
- c) sport hunting of bison in these areas would be encouraged;
- d) aerial hunting for control would be used when required; and
- e) transboundary groups of bison would be eliminated.

II Habitat Management

Habitat change that would encourage the movement of bison across the park boundary particularly to the west would not be permitted. This refers primarily to agricultural development and growth of hay crops that would be particularly attractive to bison. This type of action would require a coordinated land management plan for the area of concern around the park, the extent of which would be determined by research.

III Fencing

Short sections of fence would be used to deflect minor bison movements and could be used to ensure segregation of cattle and bison in areas where the threat of contact is severe.

IV Surveillance

Intensive surveillance of the area surrounding WBNP is an integral part of this option.

V Research

Research to gather baseline data on bison movements, population dynamics and disease transmission is required for successful implementation of this option.

This option would only be implemented if the participating agencies agreed to an approach in writing, and received funding from Treasury Board, including a commitment to financially support the required research for a period of 5-10 years.

5.2.9.2 Implications

If this option fails, diseased hybrid bison and the MBS wood bison herd will make contact and a large continuous population of infected bison will range through northern Alberta and NWT. The disease problem will essentially be out of control. If the option succeeds, most agencies' objectives will be met, although the potential for disease transmission will remain and long-term success will depend entirely on continuing vigilant surveillance and active elimination of bison in the buffer zone.

Political

- a) **Local:** Eliminating bison in the buffer zone outside the park will reduce population numbers in the herd. Local people will have a large number of animals available for hunting, but environmental groups may view this active elimination program negatively, particularly as endangered wood bison would also be hunted in the buffer zone.

- b) **National:** This option will interfere with the Wood Bison Recovery Program as wood bison could not be returned to all areas of their historic range. The present diseased herd and potential for agricultural concerns would remain. The present Agriculture Canada surveillance programs would have to be maintained to verify that disease had not spread to livestock in the area. This option will preserve the park herd as discussed and approved in the WBNP Management Plan.
- c) **International:** The International Union for the Conservation of Nature and Natural Resources (IUCN) would identify the disease risk to wood bison. Testing for export markets would have to continue indefinitely.
- d) **Public Lobby Groups:** Cattle industry lobby groups would likely be skeptical that their concerns were being dealt with effectively by this approach. Environmental groups may react negatively to the large bison-free area, to the active elimination patrols, and to the hunting of wood bison in the buffer zone. Native organizations and sport hunters may take exception to active elimination of bison they wish to hunt.

Agriculture and Animal Health

Agricultural development would not be allowed in the area surrounding the park, and some risk would still remain that bison could contact livestock or game-farmed animals. Agriculture Canada would have to maintain their surveillance program in northern Alberta at a cost of at least \$500,000 per year.

Tourism

There would be no disruption of tourism in WBNP, but the large buffer zone may interfere with tourist activities outside the park.

Existing Bison Populations

The WBNP herd would be restricted in area and would lose permanently all animals that left the park. The GNWT would have to restrict expansion of the MBS and the Nahanni-Liard herds and may have to re-evaluate their current management plans for expansion of the existing herd in the SRL. The Hay-Zama project in northern Alberta would also be subject to re-evaluation.

Wood Bison

The use of buffer zones to prevent disease transmission has not been proven successful, and there will be doubt about the option's effectiveness in preventing the spread of disease to the MBS wood bison herd. A large proportion of wood bison historic range would be unavailable for reintroduction of the species.

Legal and Policy

The establishment of Wildlife Management Zones would be required to permit hunting in the area surrounding WBNP. An agricultural development policy would be required to limit the establishment of ranches in the buffer zone. Some anticipated difficulties in this regard could be eliminated if the buffer zone were partially or completely in the park. Treasury Board funding would be required for the intensive on-going surveillance and research programs which are integral to this option.

Public Health

There would be uncontrolled hunting in the buffer zone. Native people in the NWT can now hunt hybrid and plains bison and there is no protection for non-wood bison in Alberta. The general licensed public would be allowed to hunt bison in the NWT part of the buffer zone. This would increase the number of people at risk of infection from handling or consuming diseased bison.

5.2.9.3 Feasibility

Political

This option has a high risk of failure and an accompanying high cost in political terms.

Effectiveness

There is no precedent for successful control of bison movements with this type of buffer zone and operational plan. The plan requires intensive surveillance in the buffer zone in perpetuity. If the plan fails and the MBS herd makes contact with the WBNP herds, the disease problem may expand beyond the bounds of control.

Logistics

The buffer zone would have to be defined in all jurisdictions and would include an enormous area, the size of which reduces the probability of successful surveillance. It may be necessary to implement a staged surveillance program in which areas are designated for intensive or less intensive surveillance.

Time and Cost

These considerations have not been addressed.

5.2.9.4 Information Gaps

Information will be required in order to design the surveillance program - what type of surveillance would be most effective, how often, do requirements change over the year, etc. It will also be necessary to determine the size of the buffer zone and the physical form it will take. A better knowledge of the movement patterns of the herds will be needed to locate areas where fencing is appropriate. An assessment must be made of the impact of the buffer on herd movements - will a depopulated buffer zone act to draw animals into its under-utilized range?

5.3 Summary

Nine options were examined, only four of which were considered practicable solutions. The others were discounted for scientific or technical reasons (i.e. past experience had proven that the techniques proposed were ineffective or the physical dimensions of the plan were beyond the scope of the participating agencies to maintain and enforce). None of the options was eliminated for strictly economic or political reasons.

The Task Force attempted to examine the basic range of options available to the participating agencies. The many composite options, made up of combinations of the basic plans, were not examined, though one (Option #9) is presented as an example of a composite option. The Task Force acknowledges that other options may be suggested during public forums or interest group discussions, and these should be evaluated carefully at the appropriate time.

The four options considered in greater detail by the Task Force were:

- a) Status Quo (#1)
- b) Wood Bison Recovery and Disease Eradication (#2)
- c) Fencing of WBNP (#3)
- d) Confine Disease to WBNP - Composite Option (#9).

The urgency of the situation is apparent. In the very near future, regardless of the work of the Steering Committee, other agencies may be forced to take steps independently to protect the MBS herd from contacting the hybrid diseased animals in and near WBNP. It is acknowledged that this contact could occur at any time, and should it occur, the bison disease problem may expand to such proportions that solutions may never be possible.

5.4 References Cited

- Van Zyll de Jong, C. G. 1986. Systematic study of Recent bison with particular consideration of the wood bison (Bison bison athabasca Rhoads 1898). Nat. Sci. #6, National Museums of Canada, Ottawa, 69p.

APPENDIX I

REPORT TO STEERING COMMITTEE

FROM

DISEASED BISON WORKING GROUP

SEPTEMBER 1986

REPORT TO THE STEERING COMMITTEE

The assignment to the Diseased Bison Working Group was to prepare a situation appraisal. This would include identifying concerns regarding brucellosis and tuberculosis in bison inside and outside WBNP. Also we were to identify government agencies and individuals concerned. Each concern was to be defined, agencies and their viewpoints identified, and seriousness evaluated. This situation appraisal was to constitute the discussion document for a future meeting of interested government agencies.

Interviews were held with 23 people from nine government agencies, to establish who was concerned and what were those concerns. It was felt it was premature to establish official agency responses and this may jeopardize individual concerns.

We have identified concerns without putting a name or agency beside them (APPENDIX A). We have identified agencies and people concerned (APPENDIX B). We have listed relevant observations and we have made a few recommendations.

In summary - Only government agencies were interviewed. Without exception everyone was concerned and felt serious consideration of the situation was required. It was also felt that due to the sensitive nature of the subject, it was premature for discussions outside government agencies.

OBSERVATIONS

In many cases other government agencies agreed and supported our initial 12 concerns expressed in APPENDIX A.

Below are additional viewpoints:

1. National and International credibility of WBNP, and Parks Canada in particular, may be endangered if precipitous action is taken.
2. Diseased bison may endanger the health status of neighboring bison and cattle.
3. There are no reported instances of domestic livestock near WBNP having been infected with these diseases by bison despite a long history farming-ranching in the area.
4. There is concern for the health of hunters using bison.
5. There is concern that spread of these diseases in the WBNP area would negatively affect Alberta and Canadian agricultural industries.
6. Governments may be taken to task by the public for lack of action in curtailing and publicizing these diseases.
7. Concerns regarding game ranching varied from potential infection, Hybridization, compensation, validity of tests, and appropriate legislation for movement.
8. Any management action will be subject to widespread media attention.
9. Effectively dealing with these problems will have considerable monetary and political costs, regardless of what tasks and options are chosen. A number of agencies are prepared to accept at least some of the monetary responsibilities.

OTHER OBSERVATIONS

1. Agriculture Canada may consider zoning to better control movements of domestic livestock.
2. If this potential for infection has existed for fifty years, why have Health authorities not encountered disease problems in native peoples? There is a feeling that further field investigation should be done.
3. There already exists a Bison Management Committee with two task forces under the Western Wildlife Directors and the CWS.
4. Hybrid bison may endanger the genetic integrity of neighboring wood bison herds.
5. Hybridization of existing plains bison stock, through intentional breeding practices of ranches (managers), may threaten existing plains bison populations.
6. There may be problems regarding the regulations affecting the hunting of bison vis a vis hybrids versus wood bison.
7. Provincial cabinet approval has been received for an Integrated Resource Plan of approximately 65,000 acres east of Fort Vermilion.
8. The Fort Vermilion Grazing Reserve has 2,000 cattle from as far as central and southern Alberta.
9. There is a "Native Affairs Secretariat" which includes membership of all native bands and Metis associations. Mr. Jim Monzer is the chairman of the agriculture subcommittee.
10. Some other personnel have knowledge worth tapping:

Dr. Demetrius Todosijczuk

Director of TB Services
Community Health Services
c/o Aberhart Hospital
11402 University Avenue
EDMONTON, AB

(403) 432-6455

Mr. John Lawson

Head, Animal Science Section
Animal Research Station
Agriculture Canada
P.O. Box 3000 Maine
LETHBRIDGE, AB

(403) 327-4561

Dr. Otto Schaffer

(retired - Health and Welfare)
c/o Charles Camshell Hospital
12815 - 115 Avenue
EDMONTON, AB

(403) 452-8770

RECOMMENDATIONS

ALL GOVERNMENT AGENCIES INTERVIEWED EXPRESSED A DESIRE TO CONFRONT THESE PROBLEMS. A GENERAL FEELING EXISTED THAT WE SHOULD NOT IGNORE THEM, LESS AT SOME FUTURE DATE WE BE FORCED INTO UNDESIRABLE ACTION.

1. A TASK FORCE OF SCIENTIFIC PERSONNEL FROM EACH OF THE KEY CONCERNED AGENCIES BE ESTABLISHED TO PROVIDE AGENCY MANAGEMENT WITH GUIDANCE IN THIS MATTER.

APPENDIX A.

WBNP BISON SITUATION ANALYSIS

1. **Concern:** The extent of movement and numbers of bison involved in and around WBNP.
Background: - bison cross park boundaries on three corridors;
 - a) the Peace River Lowlands on the southwest side of the Park.
 - b) the Slave River Lowlands on the northeast side of the Park.
 - c) the southeast corner of the Park across the Embarras River.
 - approximately 65 bison were shot by hunters in 1984-85 between the Park and Fort Vermilion, Alberta.
 - approximately 120 bison were shot by hunters in 1984-85 between the Park and Grand Detour in the Slave River Lowlands, NWT.

2. **Concern:** What bison populations do bovine brucellosis and tuberculosis impact on in the region?
Background: - there are approximately 5000 free-ranging hybrid bison in WBNP; the prevalence of brucellosis is approximately 35.7% and tuberculosis is approximately 35.8%.
 - there are approximately 400 free-ranging hybrid bison in the Slave River Lowlands between Grande Detour and Hook lake; these have similar prevalence of brucellosis and tuberculosis as the bison in WBNP.
 - there are approximately 1500 free-ranging wood bison in the Mackenzie Bison Sanctuary (Fort Providence, NWT), and 35 wood bison under fence but for subsequent release near Hay-Zama Lakes, Alberta. The latter wood bison are free of diseases while the health status of the former herd is uncertain.
 - there is a privately owned herd of approximately 150 plains bison between WBNP and Fort Vermilion, Alberta. These are free of the diseases.
 - a proposed bison ranch is under negotiation in the Slave River Lowlands.

3. **Concern:** What domestic animals are at risk?
Background: - there are small cattle operations on Ryan Island, Alberta, adjacent to WBNP, and at Mills Lake, NWT, near the Mackenzie Bison Sanctuary.
 - there are small herds of horses at Jean D'Or Prairie and Fox Lake, Alberta.
 - Fort Vermilion agricultural zone - there are 2500 head of cattle in 90 herds east of High Level, Alberta; 300 head of cattle in 10 herds between Fort Vermilion, Alberta, and the WBNP boundary.
 - the Fort Vermilion Grazing Reserve, 15 miles north of Fort Vermilion has just under 2000 head of cattle committed for the 1986 grazing season. These cattle are from Fort Vermilion, Provost, Camrose and Ardrossan areas. Any contamination of these cattle could spread the diseases province wide.
4. **Concern:** What other species of wildlife are involved or at risk?
Background: - Bison and elk are the only primary wildlife reservoir species that occur in Canada.
 - Brucella abortus has been isolated from four wolves, a red fox and a moose in WBNP; these represent satellite infections from the bison.
 - brucellosis appears to be a serious, usually fatal, disease in moose.
 - bovine tuberculosis has not been detected in any wildlife species except bison in and around WBNP.
5. **Concern:** What Impact do these diseases have on game ranches and regulations?
Background: - bison and elk are the species of choice for game ranching in western Canada and they are both potential primary reservoirs of brucellosis and tuberculosis.
 - there are approximately 5000 privately owned bison in Alberta; the largest of these herds are in northern Alberta.
 - a commercial bison ranch is under negotiation in the Slave River Lowlands.
 - the developing program to eradicate brucellosis and tuberculosis from game ranches and zoo species will be jeopardized as long as the diseases remain in free roaming bison in Canada.

- resources expended on eradication program costs (government operational costs, game ranchers costs or losses, compensation paid for diseased animals destroyed-estimated \$500. per game ranch) will be sacrificed (extrapolated from program costs for the Canadian cattle herd on a per herd basis).
- game ranches in the vicinity of diseased free roaming bison would be subjected to strict movement controls.
- there is a potential adverse effect of the marketing of meat from game ranches due to public awareness of the diseases in bison.

6. **Concern:** What is the public health impact of these diseases?
Background: - there have been at least six recorded cases of brucellosis in northern Canada among native peoples who consume brucellosis infected caribou.
- brucellosis (Undulant Fever) in people is chronic, recurring, debilitating disease especially in people not receiving immediate medical attention.
 - as long as the disease exists in bison of the region, exposure of native peoples will be constant.
 - in Australian and French studies, 50% of abattoir workers developed brucella antibodies with exposure to a much lower rate of carcass infection.
7. **Concern:** What are regional development plans and impact?
Background: - Cabinet approval exists for expansion of Jean D'Or Prairie.
- potential development from WBNP through Zama Lakes.
 - nine to ten million acres to develop as demand occurs.
 - several developments along fringe - Jean D'Or Prairie.
8. **Concern:** What effect does bovine brucellosis and tuberculosis have on bison?
Background: - Brucella abortus causes similar lesions in bison and cattle: abortion, retained placenta, metritis, orchitis, arthritis, tenosynovitis.
- Mycobacterium bovis causes similar lesions in bison and cattle, ranging from caseous lymphadenitis to fulminating, multisystemic disease.

- debilitation due to brucellosis and/or tuberculosis increases the susceptibility of bison to predation.

9. **Concern:** Some approaches to the management of bovine T.B. and Brucellosis in Wood Buffalo National Park may impact on Parks Canada's national and international credibility.

Background:

- Historical**
- disease status of park prior to 1925 is unknown.
 - diseases likely brought to the park during the 1925-28 introduction of bison.
 - suspected cases of both diseases were obtained from early slaughters but were not confirmed until 1947 and 1956.
 - there have been no recorded instances to date of either of these diseases being spread to domestic livestock by Park bison although there have been a number of farms/ranches in close proximity to the Park for the past 50 years.

Parks Canada Policy

- management of national parks should not be in isolation from surrounding area.
- manipulation of naturally occurring processes including disease may take place if monitoring has shown that:
 - a) there may be serious adverse effects on neighbouring herds
 - b) public health or safety is threatened
 - c) natural processes have been altered by man and manipulation is required to restore the natural balance
 - d) the population of an animal species which has been prescribed in the objective for a Park cannot be maintained by natural forces

Park Management Plan

- Parks Canada will ensure the survival of all wildlife populations. These include nationally and internationally significant resources of the Park including free-roaming bison.
- non intensive techniques will be used to manage wildlife resources and will sufficiently manage and protect en-

dangered or sensitive wildlife species such as bison so as to ensure their continued survival.

International Recognition

- RAMSAR site - wetlands of international significance.
- World Heritage Site - UNESCO designation of an area of international significance in which bison figure.

General

- largest free-roaming bison herd in the world.
- any management action could be the subject of wide-spread media attention.

10. **Concern:** What impact does this situation have on national eradication programs?

- Background:**
- as long as the diseases exist in WBNP region, special testing and surveillance procedures will need to be conducted on cattle herds in the vicinity and in northern Alberta (annual estimated cost \$400,000.).
 - transmission to cattle would mean the loss of Canada's brucellosis and tuberculosis free status (established at a cost of \$350. M).
 - Canada's international credibility will be questioned as long as the diseases exist in Canada.
 - Agriculture Canada's credibility with the cattle industry will be questioned as long as the disease risk exists in bison.

11. **Concern:** What is the epidemiological significance of the regional reservoir of bovine brucellosis and tuberculosis?

- Background:**
- bison are long-lived, primary reservoirs of bovine brucellosis and tuberculosis; the diseases will persist indefinitely in the population.
 - infected bison are not geographically or jurisdictionally restricted, and they can move considerable distances.
 - diseased bison are a food resource for people in the region.
 - this is the final uncontrolled reservoir of bovine brucellosis and tuberculosis in Canada.

12. **Concern:** What is the impact on national and international livestock markets and movement?

Background: - complete freedom from the diseases among all domestic and wildlife species in Canada would allow Canada to negotiate the elimination of brucellosis and tuberculosis testing for exported cattle, elk and bison and for semen and embryo donors which currently costs approximately \$600,000. per year.

- if the diseases spread to cattle in the Northern Alberta region, stringent movement controls and testing requirements will be placed on Alberta cattle to allow access to markets in other provinces and to international markets.

APPENDIX B.

PERSONNEL INTERVIEWED

Alberta Energy and Natural Resources:

Bill Hall	Assistant Director Wildlife Management Alberta Energy and Natural Resources 9920 - 108 Street EDMONTON, AB T5K 2M4	(403) 427-6752
Bob McFetridge	Regional Wildlife Biologist Alberta Energy and Natural Resources Postal Bag 900-26 PEACE RIVER, AB T0H 2X0	(403) 624-6405

Alberta Agriculture:

Arvid Aasen	District Agriculturist Alberta Agriculture Box 40 FORT VERMILION, AB T0H 1N0	(403) 927-3712
Dr. Terry Church	Head Preventive Medicine Branch Animal Health Division Alberta Agriculture O.S. Longman Bldg. P.O. Box 8070 EDMONTON, AB T6H 4P2	(403) 436-9343
Mel Miller	Land Use Coordinator Land Use Activities Alberta Agriculture 7000 - 113 Street EDMONTON, AB T6H 5T6	(403) 427-5354

Alberta Health:

Dr. Hilary Winters	Medical Officer of Health South Peace Health Unit 10320 - 99 Street GRANDE PRAIRIE, AB T8V 6J4	(403) 532-4441
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Dr. John Waters	Director Communicable Disease Control Epidemiology Community Health Services 10030 - 107 Street EDMONTON, AB T5J 3E4	(403) 427-5263
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Health and Welfare Canada:

Dr. Harry Hodes	Regional Director Medical Services Alberta Region Health and Welfare Canada 401 Toronto Dominion Tower Edmonton Center EDMONTON, AB T5J 2Z1	(403) 420-2692
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Dr. Mei-Fun Seto	Program Medical Officer Public Service Health (address same as above)	(403) 420-2697
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Arthur Murphy	Regional Environmental Health Officer (address same as above)	(403) 420-2688
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Judith McLennan	Zone Nursing Officer Northern Alberta Zone, Medical Services Health and Welfare Canada 400 Guardian Building 10240 - 124 Street EDMONTON, AB T5N 3W6	(403) 420-2681
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Environment Canada:

Hal Reynolds	Wildlife Biologist Canadian Wildlife Service Western and Northern Region Environment Canada Room 230, 4999 - 98 Avenue EDMONTON, AB T6B 2X3	(403) 420-2525
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Government of Northwest Territories
Department of Renewable Resources:

Jim Bourque	Deputy Minister Dept. of Renewable Resources Gov't of Northwest Territories YELLOWKNIFE, NWT X1A 2L9	(403) 873-7420
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R. Wooley	Assistant Deputy Minister Field Operations Dept. of Renewable Resources Gov't of Northwest Territories YELLOWKNIFE, NWT X1A 2L9	(403) 873-7420
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Kevin Lloyd	Director, Wildlife Management Division Dept. of Renewable Resources Gov't of Northwest Territories YELLOWKNIFE, NWT X1A 2L9	(403) 873-7420
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Dr. Cormack Gates	Regional Biologist Dept. of Renewable Resources Gov't. of Northwest Territories FORT SMITH, NWT X0E 0P0	(403) 872-7333
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**REPORT OF WORKING GROUP - TO STEERING COMMITTEE
WOOD BUFFALO NATIONAL PARK DISEASED BISON PROJECT**

Working Group:

Mr. Ken East	Superintendent WBNP Parks Canada FORT SMITH, NWT X0E 0P0	(403) 872-2349
Dr. Wm. Bulmer	Associate Director, Disease Control Food Prod. and Insp. Branch Agriculture Canada 2255 Carling Avenue OTTAWA, ONT K1Z 0Y9	(613) 955-5433 Ext. 212
Dr. Len Anderson	Regional Veterinary Director Food Prod. and Insp. Branch Agriculture Canada #751 - 220 - 4 Avenue, S.E. Bag 2998, Postal Station "M" CALGARY, AB T2P 3C3	(403) 292-5818
Mr. Bob Redhead	Chief Park Warden WBNP Parks Canada FORT SMITH, NWT X0E 0P0	(403) 872-2349
Mr. R. Leonard	Wildlife Management Officer Parks Canada 457 Main Street, 4th Floor WINNIPEG, MAN R3B 3E8	(204) 949-7869

Dr. Stacy Tessaro	Veterinary Pathologist Agriculture Canada Animal Pathology Lab. 116 Veterinary Road SASKATOON, SASK S7N 2R3	(306) 975-4071
Dr. Rex Coupland	District Veterinarian Food Prod. and Insp. Branch Agriculture Canada 222 Federal Building GRANDE PRAIRIE, AB T8V 0X9	(403) 532-4071

Government Agencies Interviewed

Alberta Fish and Wildlife
Alberta Agriculture
Alberta Health
Alberta Land Use/Planning
Canada Health and Welfare
Canadian Wildlife Service
NWT Renewable Resources
Parks Canada
Agriculture Canada

APPENDIX II

Option #2 Estimated Costs

The following list of costs associated with Option #2 is not detailed or complete. The figures are based only on known items and rates and the estimates contained here are for discussion or comparison purposes only.

a) **Taxonomic Evaluation**

Costs of the genetic salvage program have not been estimated.

b) **Depopulation Phase**

Goal - To remove 100 bison/day for total of 1500 bison in one month. This theoretically would be repeated for three years, but it is recognized that once hunting begins, the animals will be progressively more difficult to find due to diminishing numbers and behavioural changes.

- Abattoir (Portable) \$100,000

(Architect Mr. P. Palja, Calgary, quoted a portable trailer type abattoir meeting federal standards in 1983 at \$50,000. This price will have increased since that time and a bunk trailer will also be required increasing the estimated total to \$100,000.)

- Fixed Wing Surveillance
(200 hr @ \$300/hr) \$ 60,000/yr for 3 yrs

- Helicopters (2)
(\$1200/hr X 200 hrs X 2) \$480,000/yr for 3 yrs

(This is largely unknown. It is difficult to establish time required to go out, shoot and return with bison, many variables.)

Bell212 \$1035/hr + \$160/hr fuel - 130 mph carries 1500 lbs

- Wages (20 persons) (\$15/hr 8 hr/day - 20 days) \$ 48,000/yr for 3 yrs

(15 butchers, 5 others - may be able to hire \$10/hr but allowed \$15/hr due to field conditions).

- Maintenance and Operation \$100,000/yr for 3 yrs

(Fuel \$200/hr X 200 hrs, food \$30/day/person.
Helicopter shuttle materials \$600 X 50 hrs) ????

- Miscellaneous ???? \$ 25,000/yr for 3 yrs

Based on federal meat inspection records, about 10% of the carcasses would be condemned. Therefore if 1500 animals were slaughtered, about 1350 would be dressed. Based on previous bison slaughters, (Elk Island Park), the average dressed weight would be 600 lbs. The total weight for shipping would be $1350 \times 600 = 810,000$ lbs/yr for 3 years. Transportation costs would be approximately \$50,000 per year if the decision was to distribute the meat to local communities. Consideration has not been given to selling the meat.

Total cost of Depopulation Phase

(expanded for 3 years) \$2,389,000
(including trucking to local communities)

c) **Post-depopulation Surveillance and Field Slaughter Phase**

- Fixed Wing Surveillance
(200 hrs @ \$300/hr) \$ 60,000/yr for 10 yrs
- Field Crews (2 crews)
(3 person each crew = 6 person)
- Wages - \$15/hr/8 hr/day
- 20 days X 6 persons \$ 14,400/yr for 5 yrs
- Miscellaneous ???? \$ 15,000/yr for 5 yrs

Total cost of Post-depopulation Surveillance and Field Slaughter (expanded for 10 years) \$ 747,000

d) **Repopulation Phase**

A site for the enclosures must be selected and field studies conducted to establish the carrying capacity.

- Enclosures (2) (enclosures 10 km X 10 km double fence) = 80 km
- fence enclosure = 160 km fence total (160 X \$10,000) \$ 1,600,000

(Costs at Elk Island Park are approximately \$6,000/km. The costs of material and labour in the north and poor site accessibility are reflected in an increase in estimated costs to \$10,000/km).

- Maintenance of corrals (calculated as replacing corral in 20 years)
\$ 80,000/yr for 15 yrs
- Capture corrals - at existing research facility MBS - 20 km
fence \$ 200,000
- Helicopters (2) (herding 2 X \$600/hr X 30 hrs
\$ 36,000/hr for 10 yrs
- Trucking of wood bison to WBNP enclosures

A truck that carries 20 bison costs \$2/km The distance from Elk Island National Park to Fort Smith is approximately 1500 km. Elk Island could supply 30 bison/yr = 2 truckloads
2 X \$2 X 1500 = \$ 6000/yr for 10 yrs

The distance from Mackenzie Bison Sanctuary to Fort Smith is

approximately 450 km. Mackenzie Bison Sanctuary could supply 90 bison =
5 truckloads

5 X \$2 X 450 = \$ 4500/yr for 10 yrs

Operational and Maintenance ???? (5 men, 5 days)

= \$10,000/yr for 10 yrs

Miscellaneous ??????

\$ 2000/yr for 10 yrs

Labour costs - 2 PY (\$25,000/yr/person)

= \$50,000/yr for 15 yrs

Total cost of the Repopulation Phase

(expanded over 15 years) \$4,135,000

THE TOTAL COST OF THE ENTIRE HERD REPLACEMENT OPTION
WHICH WILL SEE THE PRESENT POPULATION OF 4500 DISEASED
HYBRID BISON REPLACED WITH ABOUT 9000 DISEASE-FREE WOOD
BISON IN FIFTEEN YEARS, WOULD BE \$7,271,000.

Note:

1. No costs have been included for retrieving wood bison from WBNP or SRL.
2. No calculations have been made for selling bison meat for return revenue.
3. After hybrid animals are eliminated, in this scenario by year 5, Agriculture Canada would save at least \$0.5 million a year on disease surveillance costs.

Feeding Replacement Stock

If the goal is to have as many bison as possible to release into WBNP at the conclusion of the depopulation phase, it may be necessary to consider feeding the bison in corrals. This large bison herd may be pleasing to the public, but Parks

biologists warn it would damage the environment by concentrating animals in corrals and by introducing non-native plants in feeding hay brought in from other areas. Careful consideration of these problems may dictate harvesting local hay, raising replacement bison in other locales, building more corrals, rotating pastures, or keeping fewer bison.

For discussion purposes, the following estimates of feed costs have been prepared. The dairy herd in Yellowknife in 1986-87 bought alfalfa from Brooks, Alberta. The hay cost \$95.00 per ton and the transportation to Yellowknife was \$115.00 per ton, for a total of \$210 per ton.

It is estimated that bison require approximately 25 lbs of hay per day. Therefore 1000 bison require 25,000 lbs or 12.5 tons of hay per day. The cost of feeding 1000 bison for one day on hay from Brooks would then be 12.5 tons X \$200. (approx.) = \$2500/day.

If 1000 bison are fed for 350 days the cost is \$875,000 per year. Obviously the costs would be much less if hay was purchased closer. Hay can be obtained from High Level, Fort Vermilion or Hay River.

Other alternatives would include harvesting local wild hay (this would prevent introducing foreign species into WBNP), or building more corrals as they were required, or releasing animals before 15 years had elapsed if intensive surveillance assures that all hybrid bison have been removed.

Summary of Feeding Costs:

<u>Year</u>	<u>Bison Fed</u>	<u>Cost of Feed Delivered (\$)</u>
7	200	175,000
8	600	525,000
9	1300	1,137,000
10	2000	1,750,000
11	2700	2,362,500
12	3600	3,150,000
13	4800	4,200,000
14	6200	5,425,000
15	would turn loose 9100 bison.	
Total Costs		\$18,725,000

Note: No feeding would be required until Year 7.

Cost of corrals to hold 1,400 bison with no feeding = 1,600,000

Feed costs do not include machinery to feed hay.

Feed costs are not included in the above summary
of Wood Bison Recovery Option costs.